The Current State of Green Building Standards and Interior Materials; Are These Processes Leading to Stronger Selections of Sustainable Materials?

by

Leah Lasani

A thesis

presented to the University Of Waterloo

in fulfilment of the

thesis requirement for the degree of

Master of Environmental Studies

in

Sustainability Management.

Waterloo, Ontario, Canada, 2016

Author's Declaration

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

Leah Lasani

Abstract

The environmental impacts of buildings include energy and land use, greenhouse gas emissions, natural resource depletion, and solid waste. And while a building's envelope and operational energy use are often considered the most important in the context of sustainable design, a building's interior materials also play a large role in a buildings' adverse environmental impacts. Although the architecture and design communities have begun to recognize the environmental burdens of buildings, as evidenced within the last 20 years by the creation of green building rating systems (GBRS) and ecolabeled, or certified green, interior materials, there still remains uncertainty and conflicting approaches to environmentally responsible design and material specification. An increasing number of architects and interior designers have accreditation and experience working with GBRS, yet only a small percentage of interior materials used in buildings today meet some criteria of being environmentally preferable.

Given the need to build buildings more sustainably (to help mitigate climate change), and the importance of environmentally preferable interior materials in meeting that need, the question of why and how these materials are or are not specified is an important one to answer. It is also of value to understand the influences current decision making tools have on architects and interior designers. In recognizing both the influences and challenges with the current decision making processes, this study aims to explore the current use of GBRS, adoption of environmentally preferable interior materials through ecolabels and certification standards, and the connection between the two. Primary data were collected through a web survey of architects and interior designers practicing in Ontario.

The results of the analysis of the systems and labels and academic research on this topic identify and support some of the benefits of, and existing barriers to, environmentally preferable interior materials. The survey results indicate that, although participating architects and interior designers rate sustainable design and environmentally preferable interior materials as important, green interior materials specified by architects and interior designers was low, and rarely requested by clients. Further, although almost half of survey participants have a recognized green training or designation, there is little connection between; a) these accreditations and the use of tools and resources available to assist with selecting green materials, and b) the amount of certified green materials being specified. The results of this research help to bridge the gap between the ideals of building councils, building material manufacturers and certifications organizations, with the practising realities of architects and interior designers, leading to higher rates of environmentally preferable materials specifications.

Keywords: green building, sustainable design, green materials, LEED v4, cradle-to-cradle, eco-labels

Acknowledgements

I am so thankful to both of my incredible advisors, Professor Geoff Lewis and Professor Jennifer Lynes. Geoff- your support and encouragement for my endless topic exploration (a.k.a. “shiny ball syndrome”) gave me confidence and clarity, and helped me in finally landing on this topic, knowing it was the right one. I also thank you for the global Skype chats…you could never lose me. Jenn- your support came exactly as I needed it, and I truly could not have gone through the survey process without you. I hope you don’t regret giving me your phone extension. And, like Geoff, you can’t lose me either, neighbour. To both of you, your combined passion for sustainable building, and living, has given me not only the drive to complete this thesis, but also to know that living and breathing sustainability has to potential to help change the world. To my committee member, Professor Terri Boake, thank you for showing such interest and support in this topic and my research.

I am so grateful to my husband, Shabbir, for his initial encouragement of this program and his support in helping me manage a full-time job, studies, teaching yoga, then a new baby and a thesis. I truly could not have completed this journey without you by my side, encouraging and grounding me, every step along the way. Finally, to my parents, who instilled in me a constant need for knowledge and self-growth, and though this sometimes made my plate too full, I always knew I had you there, cheering me on. I could not have completed this thesis without your support and babycare, for which I am forever grateful. Thank you for always teaching me to believe I can, and will, reach my goals.

Dedication

"*Never doubt that a small group of thoughtful, committed citizens can change the world; indeed, it's the only thing that ever has.*" -Margaret Mead

This research and study is dedicated to my daughter, Whitney Ann Lasani. It is for her, and her generation, that I sincerely hope will be able to live in a world that rests and thrives in balance.

Whitney- may you always enjoy, respect and appreciate the beauty and peace of all living things on this planet.

Table of Contents

List of Figures

Lists of Tables

List of Abbreviations & Acronyms

ARIDO- Association of Registered Interior Designers of Ontario
C2C- Cradle-to-cradle
CaGBC- Canada Green Building Council
CDW- Construction Debris & Waste
BREEAM- Building Research Establishment Environmental Assessment Method (UK)
EPD- Environmental Product Declaration
EPP- Environmentally Preferred Product
ERD- Environmentally Responsible Design
HPD- Heath Product Declaration
IAQ- Indoor Air Quality
ISO- International Organization for Standardization
LCA- Life Cycle Assessment
LEED- Leadership in Energy and Environmental Design
GHG- Green House Gas
GWP- Global Warming Potential
OAA- Ontario Association of Architects
SAN- Sustainable Agriculture Network
SCS- Scientific Certification Systems
TPB- Theory of Planned Behaviour
USGBC- U.S. Green Building Council

1. Chapter I:

1.1. Introduction

The environmental impact of buildings is substantial across many contexts; energy and land use, greenhouse gas emissions, natural resource depletion and solid waste generation. A building's interior materials play a large role in a buildings environmental impacts, and though architecture and design communities have begun to recognize the environmental burdens of buildings within the last 20 years, uncertainty and conflicting approaches to sustainable design remain. Though the creation of green building standard systems and ecolabelled or certified green interior materials aim to increase the amount of green material knowledge and specifications, only a small percentage of interior materials used in buildings today meet some criteria of being environmentally preferable (Speigel & Meadows 2010,). Furthermore, fewer than half of building professionals have experience in the specification of environmentally preferred interior materials (Mate 2006, Kang & Guerin 2009, Rider et al. 2011).

While a building's envelope and energy use have typically been of highest concern, an interesting paradigm shift on the impact of materials is predicted by some in the industry: as buildings become more efficient and environmentally sustainable, the fraction of the building's total burden represented by materials will increase (unless the adoption of whole building life cycle and environmentally preferable material specification match the efficiency of the building itself). Although the primary focus of architects has been designing high performance building envelopes, a shift in the education, importance and adoption of environmentally preferred materials for a building's interior must occur. This shift is beginning to be reflected in the latest versions of green building ratings systems, and is evidenced as well in the material ingredient transparency movement (Baer 2013, Melton 2014b, Kibert 2016). However, based on current academic and professional studies (Kang & Guerin 2009, Bacon 2011, Gale 2011, Ahn et al. 2013), sustainable interior material specifications are not top priority for most of the professionals who specify interior materials, architects and interior designers, regardless of the relevancy of these materials within current decision making processes. Given the importance of sustainable buildings in general, combined with the need for greater uptake of environmentally preferable interior materials, the question of why and how these materials are or are not specified is an important one to answer in order to meet some of the many current, and predicted, building regulations, standards and expectations. It is also of value to understand the influences current decision making tools have on architects and interior designers, as these two professions are the main decision makers in the specification of building materials. In recognizing both the influences and challenges with the current decision making processes, this study aims to explore the current state of environmentally preferable product specifications within Ontario. First, the relevant green building rating systems (GBRS) and ecolabelled green interior materials are introduced and examined, followed by a review of the current literature on this topic. Finally, an online survey, completed by about 150 practising architects and interior designers across Ontario, was used to gain insights into the experience of building design professionals related to GBRS, ecolabels, green product certifications, and databases, as well the motivators and barriers to use. The results are then interpreted and discussed, leading to recommendations and conclusions that help to bridge the gap between environmental design in theory and practice.

1.2. Research Questions

This study aims to answer the following questions:

- Is the proliferation of green building rating systems (GBRS) building systems leading to an increase in the specification of environmentally preferred interior materials?
- How relevant, and utilized, are current decision making processes in the selection of environmentally preferred interior building materials?
- What environmental factors, and to whom they belong, are most influential in the decision making process? Are these values reflected in eco-labels and rating systems?

1.3. Definitions

Sustainable Design- Sustainability is defined as the property of things that last (Ching & Shapiro 2014).The broadest definition of sustainable design, given it is ever-evolving, organic term in today's culture, is design that encompasses the three pillars of sustainable development: environmental, social, and economic issues. For this study, sustainable design will be defined the design of buildings, interiors and products with a philosophy of equal balance of the environment, people and economy, for now and for future generations (Kang & Guerin 2009, Berge 2009).

Environmental Design- This study focuses on only the environmental issues related to materials and the built environment, rather than the three aspects of sustainable design. As such, the definition of environmental design for this study is, "a purposeful approach to the design of the built environment that does not diminish the health and productivity of natural systems (McDonough & Braungart, 2010, Steig, C. 2006), with focus on the materials' intended application, aesthetic qualities, environmental and health impacts" (Hayles, C.S., 2015, Cargo, A. 2013; Moussatche et al., 2002).

Ecolabel- identifies a product that meets a wide range of environmental performance criteria or standards (Golden et al. 2010).

Embodied energy- the total energy used in the creation of a product or material, and excluding the end-of-life/disposal (Berge 2009).

Environmentally preferable products (EPP) - materials which are verified to have less of an environmental impact than their conventional counterpart (Rider et al. 2011).

Net zero building- buildings which have a net zero energy consumption; the annual amount of energy consumed is equal to, or less than, the amount of renewable energy the building creates on site annually (Ching & Shapiro 2014).

1.4. Study Structure

The structure of this study is as follows; Chapter 1 provides an overview of the thesis, including the background of the study. Chapter 2 addresses the overall impacts of buildings and building materials from a number of different perspectives, while Chapter 3 presents the current literature on the topic of sustainable building materials, green building rating systems and ecolabels. A thorough survey of the green building rating systems, material ecolabels, databases and tools included in this study can be found in Appendices A and B. The included GBRS are: LEED v4, BREEAM, Living Building Challenge, while the ecolabels, assessment tools and eco-databases are Cradle-to-Cradle (C2C), GREENGUARD, Living Product Challenge, ECOLOGO, Life-Cycle Assessment (LCA), Environmental Product Declarations (EPD), The Pharos Project, Transparency and Declare. Chapters 4 describes the methods used in conducting the quantitative research, followed by first the survey results and interpretations presented in Chapter 5. Finally, Chapter 6 includes the survey results discussion and study conclusion. The research documentation (e.g., participant email request, Letter of Information) can be found in Appendix C, with the completed surveys presented in Appendix D.

1.5. Scope

This study tackles a large area of research: environmentally preferable interior materials within the green building industry. A topic that is currently relevant, yet challenging and ever-evolving. Narrowing the scope of this topic is necessary to ensure the findings scalable and applicable to the knowledge gap. During initial research, the inquiry of whether inclusion of green interior materials by green building rating systems (GBRS) and material ecolabels leading to more of these materials being specified, purchased and installed in projects was proposed. Surveying the professionals who have the most influence on adoption of interior materials - architects and interior designers - was the method used to best determine the motivations, barriers, and experiences in interior material specification. Although the literature review looks primarily at the empirical research done across North America, a few case studies of European standards were included, as often Europe is referenced because of their commitment to environmental building standards long before North America. From the literature review, it was found that limited research directly related to professionals working in the built environment in Ontario or Canada has been conducted, so the scope of the quantitative research was narrowed down to architects and interior designers working in Ontario, Canada. Ontario has a high number of practicing architects and designers: of the 4,753 architects listed in the members directory of the Royal Architectural Institute of Canada (RAIC), 2,028 are registered in Ontario (43%), and of the 3,174 registered interior designers in Canada published in the 2014/2015 directory, 1,802 practicing in Ontario (57%).

Licensed architects in Ontario (those who are eligible to become a member of the Ontario Association of Architects (OAA)) must have either a four year university degree in architecture with a 2-year Master's degree in architecture, or a 3-year Master's degree in architecture with a previous 4-year Bachelor's degree. Architects must also complete a minimum of two years practical experience, and have successfully completed the license examinations for licensure. Architects who are members of one of the 11 provincial/territorial architecture associations are then able to become a member of the Royal Architectural Institute of Canada (RAIC). Becoming a registered interior designer in Ontario (and/or a member of the Association of Registered Interior Designers of Ontario (ARIDO)) is based on education, experience (a minimum 4-year bachelor's degree is now required in Canada), and examination. Design practitioners take a qualifying examination, the National Council for Interior Design Qualification (NCIDQ) after completing 7 years of education and work experience, and then may use the title "Interior Designer." Interior designers who have completed the NCIDQ are then eligible to become a member of ARIDO, and/or Interior Designers of Canada (IDC). Both professions require ongoing continuing education as part of professional good-standing and membership. Architects licensed through the OAA are required to complete a minimum of 70 hours of approved learning over a 2-year period (OAA 2016) Interior designers licensed as ARIDO members must complete 30 hours, over a two year period, with a minimum with 8 CEU hours being in HSW (Health, Safety & Wellness) (ARIDO 2016). At this point, neither professional association requires any continuing education hours to be within the field of sustainable, environmental or energy design.

The current green building certification systems and product labels included in this study were selected based on popularity, the validity of the process and geographical relevancy (i.e., must be adaptable to the Ontario climate). They are LEED, the Living Building Challenge, Green Globes, and Passive House. The product labels included, also narrowed down based on validity of certification and use in interior materials, Cradle-to-Cradle, GreenGuard, ECOLOGO, FloorScore, as well as the environmental product assessment tools Environmental Product Declarations (EPD) and Life Cycle Assessment (LCA). Finally, relevant interior material databases are identified and discussed: The Pharos Project, Transparency, Designer Pages (formally GreenSpec), and Declare.

1.6. Research Background

Buildings have an enormous environmental impact. They account for nearly half (48%) of all greenhouse gas emissions in Canada (RAIC, 2030 Challenge, 2015), and each year three billion tonnes of raw materials are used for their foundations, walls, and finishes globally (Foster et al. 2007). Not only does this contribute to the depletion of natural resources, create millions of tonnes of air emissions, but the construction and building industry sends seven million tonnes of solid waste to landfill in Canada alone each year (StatsCan 2015). According to non-profit organization Architecture 2030, 5–8% of total energy consumption and greenhouse gas emissions in the U.S. results from the manufacture and transport of building products and the construction of buildings (Architecture 2030 n.d.). As an end-user of fossil fuels, the built environment accounts for more emissions than any other single sector- between 40% and 50% of global greenhouse gas (GHG) emissions (Strain 2016.), with 10-20% of total GHG emissions coming from materials (over a 50-year lifecycle) (Berge, 2009). And the future for the built environment isn't predicted to slow: according to the Royal Architectural Institute of Canada (RAIC), by the year 2035 nearly 75% of all building in Canada will be either new or renovated, increasing both energy consumption and greenhouse gas emissions (RAIC 2030 Challenge, 2015).

The push for greener buildings is stronger now than ever, and Canada specifically needs to be diligent in trying to meet global emission reductions. Although Canada was formerly a signatory to the Kyoto Protocol, Canadians have increased greenhouse gas emissions by more than 20% since 1990 (RAIC, 2016). The recent Paris climate accord set the aggressive goal of keeping global temperature from rising less than 1.5°C above pre-industrial levels (United Nations- Paris Agreement 2016), which would mean that global emissions would peak in 2020 and fossil fuels would be completely phased out by 2055. This accord then, has direct implications and opportunities for the built environment. However this study hypothesizes that there is a significant gap in recognizing the need for sustainable design and using the tools, resources, and products available to help reach these goals.

The global building industry, in recognizing the impacts buildings have on the environment, has made strides in attempting to reduce the overall footprint of buildings, creating countless rating and certifications systems, some global, some national, and many local systems. These systems, most notably the Leadership in Environment and Energy Design (LEED), have increased in number two-fold over the past decade; the number of completed and certified LEED buildings in Canada went from 1 in 2003 and 6 in 2004 to 531 in 2015 (CaGBC 2016) (LEED has five project categories, the two most relevant to this study being Building Design & Construction and Interior Design & Construction. See Appendix B, Section 1 for further discussion). However, the global evolution of green building has seen its fair share of missteps. One of the earliest wake-up calls to industry in avoiding one-dimensional solutions came in 1973. After the American Institute of Architects (AIA) placed a heavy focus on creating more energy efficient buildings (forming the Committee on Energy), reduced ventilation and tighter seals in buildings worsened indoor air quality, resulting in the new phenomenon of “sick building syndrome” (Atlee 2011).

Architects and designers can reduce up to 80 percent of the energy needed to operate buildings if they design environmentally responsive buildings (Lechner 2009). Both architects and interior designers play a critical role in the implementation of green building strategies as they can be responsible for specifying up to 75% of resources used to manufacture products (Goggin 1994). Both are trained in creating functional and appealing exterior and interior spaces, whether for a single family home, multi-unit residential building, hospital, or commercial office space. The collaboration between architects and interior designers is often dependent on the scale and budget of a project. Some architects include interior materials and finishes as part of their scope, while other projects utilize a licensed interior designer to provide interior specifications, alongside project conceptualization, design development, space planning, and construction documentation. Architects and interior designers both require a minimum of a four-year bachelor's degree, with architects requiring an additional 2-year Master's degree, and sustainable or environmental design is now mandatory as part of curriculum delivery. This current education should reduce the number of practicing architects and interior designers who state lack of education as a barrier for green design implementation (discussed further in Chapter 3.6), but this will take years to affect the complete system. Regardless of this new curriculum, the effort to gain knowledge about sustainable materials and products has been proven to be too time consuming for professionals under constant schedule pressure (Kang & Guerin 2009), even more relevant for those who did not study sustainable design in school. And, although continuing education is required for both architects and interior designers, lack of mandatory continuing education in sustainable or environmental design perpetuates the cycle of education as a barrier. One of the goals of this study is to see if environmental education or training is deficient with architects and interior designers, which may be a factor in hypothesizing the lack of sustainable material implementation.

Studies show that the most important driver of sustainable design and construction is perceived to be energy conservation (Ahn et al. 2013). With a push for net-zero energy buildings already well underway, it is likely that buildings' energy consumption will decrease, and as such, the relative environmental impact of materials will increase. And while the current focus on green building appears to be focused on reducing CO_2, as energy use results in the largest environmental impact from buildings (van den Dobbelsteen 2004), the relative growth in the impact from the materials of a building is a critical issue to begin addressing (van den Dobbelsteen 2004, Malin et. al. 2014, van Dijk et al. (2014)).Van Dijk et al. (2014) present the case in their study that materials and water currently account for approximately 20% and 3% of the environmental impact of buildings, respectively (with energy accounting for approximately 75%). However, if the energy impact decreased to 10%, materials and water would then account for 80% and 10%, respectively. Therefore, it can be assumed that the future impact of materials will increase as energy consumption decreases, thus requiring even more diligence and consideration for architects and designers who specify them.

The increasing focus on corporate environmental and social performance has led to a proliferation of "green marks", including standards, codes, labels, indices, and certifications (Golden et al., 2010). The increase of product ecolabels should provide consumers and building professionals with an accessible method to select the "most" environmentally preferable product. Yet major barriers exist, leading to only a small fraction of architects and designers specifying EPPs. Golden et al. (2010) present one of the biggest questions related to the state of ecolabels today: what labels *don't* measure could be equally, if not more important, than what they *do* measure. This contradiction will be discussed further in this study. Building professionals who take on the task of reducing health concerns from buildings face many challenges in actually selecting safer building materials (Atlee 2011). Decisions become even more challenging when new choice parameters are introduced. Which is better environmentally—linoleum or cork flooring, concrete or steel structure, paper or plastic packaging? Research has shown that consumers are happiest when they have a limited amount of information on which to make decisions (Tugend 2008).

Given the desire to decrease the environmental impacts of interior materials, many of the most influential green building rating systems (GBRS), including LEED, Green Globes, BREEAM, and The Living Building Challenge have included interior materials and resources as part of their rating systems. Also, organizations offering the certification, or labeling, of environmentally preferable products (EPP), attempt to provide consumers and building professionals information on sustainability of materials. Relatively unheard of only 20 years ago, the marketplace today is inundated with ecolabels: in a 2010 study, there were over 400 ecolabels ecolabels, ranging from foods, children's toys, building materials, furniture, electronics etc. (unfortunately, no category breakdown of these 400 ecolabels was provided in the study)(Golden et. al. 2010). The transparency movement in product or material ingredients is also gaining huge momentum in the building industry, especially related to the human health and environmental hazards associated with many of the toxic ingredients previously unknown to be in materials. Although there are decades worth of studies indicating the harmful effects of material-based hazards, i.e. lead and asbestos (e.g., Spiegel & Meadows 2010, Rider et al. 2011, Pacheco-Torgal 2012, Silvestre et al. 2014), and provided there are more than 80,000 chemicals in use in the building industry, with that number of health-damaging chemicals quadrupling since 1971 (Berge 2009) more comprehensive attention to chemical hazards in building materials is a relatively recent phenomenon and not yet widespread within the green building movement (Atlee 2011).

With a push for better and more transparently declared interior materials, incentivized by credits rewarded in many of the GBRS, one might assume that sustainable interior materials would be a) commonly specified, and b) easily accessible. This study hopes to see if either are true which propose interesting questions in the efficiency of the current systems and ecolabels, and possible identify a significant opportunity for expansion and growth of green material specifications within the building industry.

2. Chapter 2- Impacts of Interior Materials

Chapter 2 discusses the areas of considerate impact from the building industry and from interior materials directly; they are environmental and waste, as well as human health impacts.

2.1. Environmental Impacts of Interior Materials

The environmental impact of buildings is significant and, with the number of current green building programs, certifications, and inundation of information on the subject, should be on the radar for most architects and designers. However, as the empirical research shows, the frequency with which sustainable design is actually practiced is still limited, particularly where materials selection is concerned (Hayles 2015). According to Architecture 2030, 5%–8% of total energy consumption and greenhouse gas emissions in the U.S. result from the manufacture and transport of building products (Architecture2030, n.d.). Globally, building construction consumes 24% of the raw materials extracted from the lithosphere (Bribián et al. 2011). Although the building industry is not the largest user of water, the building industry diverts approximately 16% of global fresh water per year (Speigel & Meadows. 2010).

Amongst the multiple environmental impacts attributable to buildings, energy consumption has always been the one of most concern (Chen et al. 2015). However, there is likely to be a shift in the area of buildings that carries the highest impact. In a study on office buildings, van den Dobbelsteen (2004) concludes that, on average, energy use accounts for almost 80% of the environmental impact, whereas materials accounts for almost 20% and water for 3% only. However, because of the general focus within GBRS on CO_2-reduction, energy use will decrease, resulting in a relative growth of impact of materials and water. Sixty studies of different buildings, located in 9 countries (including Sweden, Germany, Australia, Canada and Japan) found that the proportion of embodied energy in materials used and life cycle assessed varied between 9% and 46% of the overall energy used over the building's lifetime when dealing with low energy consumption buildings, and between 2% and 38% in conventional buildings (Bribián et al. 2011). A number of materials currently used in the construction of buildings, such as steel, aluminum, copper, PVC, and glass entail significant environmental impacts, due to their high consumption of energy and raw materials in the numerous processes that make up their life cycle (Bribián et al. 2011).

Although interior materials are included in most of the current building rating systems, including LEED, Passive House, and The Living Building Challenge, the overall lifecycle impact of materials, especially in commercial interiors, is likely higher than intended due to one factor: *churning*. Churning is the trend in which interiors are redesigned, or updated, every 5-7 years (usually for one of two reasons: material performance or aesthetic value). When the lifecycle of materials is shortened as a result of churning, the embodied energy of materials can outweigh the operational energy costs of an office building over a forty-year life span (Hayles 2015).

2.2. Waste and the Built Environment

Buildings, in their construction, use, and end-of-life carry heavy burdens across a number of different environmental categories, with solid waste being a significant issue. As the available land for landfills diminishes, it is critical to begin reducing the amount of construction waste ending up in landfill. In a 2013 study by the Conference Board of Canada Municipal Waste Generation, Canada placed last (17 out of 17) of OECD (Organisation for Economic Co-operation and Development) countries on waste management, with the amount of municipal waste increasing steadily since 1990 (Conference Board of Canada, 2013).

The construction industry accounts for a significant amount of waste: 27% (7 million tonnes in 2012) of the total amount of solid waste sent of landfill in Canada each year is generated by the construction industry (Yeheyis et al. 2013, Stats Can 2015). The majority of construction and demolition (C&D) waste produced in Canada continues to be sent to landfills (Jeffrey 2011). In its solid waste management hierarchy, the U.S. Environmental Protection Agency (EPA) ranks source reduction, reuse, recycling, and waste to energy as the four preferred strategies for reducing waste, with this hierarchy reflected in the new LEEDv4 release (USGBC.org 2015a). The large amount of waste generated by the building industry is compounded by the prediction made by the International Energy Agency which states that commercial and institutional buildings will double by 2050 (WBCSD 2010), supported by the RAIC stating that by 2035, most buildings will be new or renovated (RAIC 2014).

A study included in Yeheyis et al., states that over 75% of waste generated by the construction industry has residual value, and therefore could be reused, salvaged, or recycled. This could prevent a significant amount of materials entering the waste stream, supporting the cradle-to-cradle approach for construction waste. Further, unlike construction waste, usually comprising off-cuts, damaged and excess building materials, demolition waste is often contaminated, potentially toxic, and fastened together, making separation, salvage, and reuse a challenge (Bribián et al. 2011, Yeheyis et al. 2013). For the recycling of C&D materials to be possible, it is necessary to promote a radical change in the design of buildings, enabling the low-effort disassembly of construction materials at the end of their service life. For this purpose, the joints between the different materials must be reversible, such as bolted joints, avoiding adhesives as far as possible (Bribián et al. 2011). The reduce, reuse and recycle concepts are addressed in the GBRS included in this study (LEED, Green Globes, BREEAM, Living Building Challenge and Passive House) and can be found in Appendix B.

The large majority of recycling actually constitutes ‘‘downcycling’’ because the recycling process reduces the quality of the materials, making them suitable for use only in lower value applications, with some materials still end up in landfills or incinerators. Their lifespan has been prolonged, but their status as resources has not been maintained (Braungart et al. 2007). Although recycling prevents some material from entering the landfill, the likelihood of it eventually becoming waste is high, as is the amount of energy used in the recycling process, a topic which will be discussed further in this study. The goal of a net-zero waste building design is to prevent any materials from entering the waste stream, in alignment with the cradle-to-cradle approach.

It is also important to consider a life-cycle approach to waste. The transportation of waste leads to higher GHG levels, toxic materials leach into the ground and off-gassing into air, and with many valuable and reusable materials being sent to the landfill, there is added pressure on natural resources to accommodate this unnecessary waste. In most of the green building rating systems (GBRS), the 3R's of waste reduction (Reduce, Reuse, Recycle) are addressed, though it is an open issue which of them support the hierarchy of reduce being first (Wu et al., 2016). All of the current GBRS address waste in one way or another, indicating its importance in sustainable building design. In the 2016 comparative analysis of waste management in GBRS, Wu et al. conclude that the LEED certification system focuses heavily on 'reuse' (63%), 28% recycle and only 9% on reduce, whereas Green Globes' focus is 40% on reduce, 22% on reuse 38% on recycle (Wu et al. 2016).

In a 2014 report, Silvestre et al. explored the end-of-life impacts and benefits of building materials, and found that an environmental assessment of C&D waste flows can be an important source of data for decision-making based on choosing between alternatives to 'close the loop' in the life cycle of building materials by identifying the ones that help to improve the cradle-to-cradle environmental performance of these products (Silvestre et al. 2014). They conclude that more studies are necessary to explore the obstacles (especially in terms of laws, cost, and scale) that hinder the choice of the best end-of-life options in environmental terms.

2.3. Human Health Impacts of Interior Materials

Though this study looks at the environmental impacts of interior materials, and their ingredients, what is detrimental to the health of the planet is often detrimental to human health as well. The U.S. Environmental Protection Agency (EPA) reports that indoor air often contains pollutant levels two to five times higher than outdoor air (U.S. EPA, 2008). With most North Americans spending 90% of their time indoors, the adverse health effects of indoor environments contribute to major health problems, including asthma and other respiratory problems, allergies, or even cancer-related deaths (Lee et al. 2013). About 80 000 chemicals are in use in the building industry, with the number of health-damaging chemicals has quadrupled since 1971and there is evidence of a number of materials emitting gases or dust which can lead to health problems for the inhabitants or users; primarily allergies, skin and mucous membrane irritations ((Berge 2009). The materials that architects and interior designers specify have a direct impact on indoor air quality (IAQ). Indoor air quality refers to the quality of the air inside a building and is influenced by concentrations of pollutants and temperature and relative humidity conditions that affect the health, comfort, and performance of occupants (U.S. Environmental Protection Agency, 2003). One of the main sources of indoor air pollution is gases or particles emitted from building materials, including flooring, paints and coatings, adhesives and sealants, wall coverings, and wood products (Spiegel & Meadows 2006). Recent studies also show that interior materials can affect respiratory and digestive systems as well as eyes and skin (Loftness et al. 2007; Natural Resources Defense Council, 2011). The effect architects have on IAQ primarily comes through the design of building systems, air flow, and building materials (often in collaboration with engineers), whereas the impact interior designers have on IAQ comes from the integration of space planning with building heating, ventilation and air conditioning (HVAC) systems, and from specifying furnishings, materials, and finishes (Kang & Guerin 2009).

The human health impacts of building and interior materials are important for many clients, architects and interior designers (often more so than the environmental impacts), with all of the major GBRS (LEED, LBC, GREEN GLOBES and BREEAM) including health and wellness factors in their rating systems. Reflecting the impact that buildings have on their occupants, a new building standard, the WELL Building Standard, was launched in 2013. The WELL system, created by the International WELL Building Institute (IWBI), was created by private company Delos as “a performance-based system for measuring, certifying, and monitoring features of the built environment that impact human health and well-being, through air, water, nourishment, light, fitness, comfort and mind” (Wellcertified, 2015). The WELL Building Standard is a program administered by both the CaGBC and USGBC.

Further representing the shift toward healthier interior environments is the Health Product Declaration (HPD), which standardizes the way of reporting the material contents of building products, and the health effects associated with these materials. Products with a complete HPD declaration must either meet the full disclosure of Intentional Ingredient requirements, or meet the full disclosure of Known Hazards requirements, or provide the role of the ingredient (with an explanation) (SCS Global Services, 2016). The intent of an HPD is that the architect or interior designer can use the data in these declarations to make informed materials choices.

It is important to note that while the scope of this study is limited to the environmental burdens, it does not discount the human health impacts of the built environment.

In summary, the burden of materials for the health of the environment and humans is high. In their production, use and end of life, materials alone use high amounts of energy, contribute to global GHG emissions, and deplete natural resources and water sources. The impact is often heavier for interior materials due to churning of materials, most often taking out products that, while may still have value, end up in landfill. However, an approach to design and material decay using the life-cycle assessment methodology is being implemented in current GBRS recognizing reduction and recycling to be the most efficient ways to reduce waste generated by the construction industry. LEED focuses primarily on material and building reuse, while Green Globes focuses on reduction. This approach should decrease the current statistic of the building industry contributing over 25% to annual waste in Canada, The human health and wellness considerations of buildings are becoming more common now than ever, GBRS also responding: all of the GBRS factor in IAQ, with WELL being focused only on the health and wellness of a building and its' occupants. Further, ecolabels including FloorScore and HPDs are offering architects and designers resources to assist in creating healthier building and interiors, which inevitably help the planet as well.

3. Chapter III: Literature Review

The current popularity of the green building movement shows that the architecture, design, and engineering communities have an interest in decreasing the environmental footprints of buildings. However, the evolution of certified green buildings and sustainable interior materials has not been without challenges, especially in the validity of their green performance, cost, and adoption levels. The following literature review identifies the current state of research on green building materials, including a review of the motivations and barriers to selecting environmentally preferred products and using green building rating systems. This review also provides an overview of the psychology of motivators and barriers to selecting green products.

3.1. Overview of Product Ecolabels in the Built Environment

Increases in the exposure of adverse environmental and health impacts from the built environment, coupled with visible effects of global climate change, have led to great leaps in the green building industry. And it may be that these are some of the reasons that have created a market for environmentally preferable products, both in want (83% of American adults consider themselves to be some shade of "green" (Ottman 2010)), and in need (LEED, Living Building Challenge, Green Globes all requiring some implementation of sustainable interior materials as part of building certification). Ecolabels and green product certifications are important for the building industry, especially for architects and interior designers, who have the most influence in mitigating adverse environmental impacts from conventional interior materials.

From both consumers and building professionals, the opportunity for purchasing environmentally preferable products (EPP) has never been greater, with proactive product and material manufacturers experimenting quite some time with how to share information on a product's environmental impacts (Atlee & Melton 2014). However, a lack of consistency within the labeling and certification processes creates confusion, greenwashing and distrust, as consumers and professionals are overwhelmed and undereducated, and struggle with questions when selecting an ecolabeled product: which label to choose? Which labels and standards are the best? How are they better with regard to environmental mitigation? Standardization becomes the key issue. The quality of an ecolabel is function of the standards it selects. As Golden et al., present in their 2010 study on ecolabels, the argument for increased oversight certainly has legs to stand on.

3.2. Ecolabels within the Building Industry

The current state of ecolabels has both benefits and challenges; products with green certifications should increase performance and health benefits, and decrease environmental impacts, yet they can be overwhelming and lead to confusion. An ecolabel identifies a product that meets a wide range of environmental performance criteria or standards, and is given to products that have met specific environmental criteria (Golden et al. 2010). In the 2010 study, Golden et al. identifies this impact measurement; does organic trump local, recycled or recyclable content matter more? The Golden et al. study also questions whether more information is better when presenting products with ecolabels; more information can improve the perceived credibility of a label, but too much information creates an overload that confuses. Even the USBGC acknowledges this challenge in the process of creating and revising Material & Resource (MR) credits for LEEDv4: "It is difficult…to compare two products that have different sustainable attributes—for example, cabinets made of wheat husks sourced from all over the country and bound together in resin versus solid wood cabinets made from local timber" (USGBC 2015a).

Product manufacturers have been under increasing pressure to modify existing products, or engineer new ones, which market their sustainability story and/or meet ever-increasing strict environmental guidelines. However, the relationship that exists between manufacturers and labels is tricky; Chatterji & Levine (2006) discuss: businesses have to be involved in the process in order for them to be integrated, however excessive participation by industry can cause concerns on legitimacy and validity. Cargo (2013) sums up this dichotomy: the sole job of the vendor is to sell their product, so they are unlikely to tell a designer of the harmful or hazardous aspects of the material or product. Furthermore, studies show that designers look to the manufactures own literature for the environmental impact of a product, and rarely search for conflicting information (Kang et al. 2009). Building products are also complex assembly systems, making categorization more difficult (Atlee & Melton 2014).

The current state of labels, standards and certification systems is complex: labels can be applied to any product without any certification or process, whereas certification means that a product or material has been evaluated and meets some predetermined criteria (and although this provides a stronger case than a label, the certification process or criteria may be elusive, at best). Certification programs fall into either first-, second- or third-party categories, which are important to understand before selecting a material based on the certification, and for integrity and transparency, should be based on a known standard(s) (Rider et al. 2011). Table 3.1 summarizes the three certification levels.

Table 3.1: Ecolabel Certification Levels (modified from Rider et al. 2011).

Certification Level	Description
First-party	Often just marketing claims or product specifications and material safety data sheets (MSDS). Made by a company about their own products- claims are not tested or verified
Second-party	Claims are verified by a trade association or consulting firm, so although more credible, often represent an industry and so may not consider larger implications
Third-party	The most credible certification program- based on established standards and third-party examination and verification.

Considered the highest level authority in standards, the International Organization for Standards (ISO) is the world's largest developer and publisher of international standards: there are 162 countries which belong to ISO, with over 18 000 standards providing practical tools for all three dimensions of sustainable development : economic, environmental and societal. Although Canada is a member, with the Standards Council of Canada (SCC), the American counterpart, ANSI, the American National Standards Institute, is more relevant in green building standards (Rider et al., 2011). The ISO 14000 standards contain the family of environmental management standards, including ISO 14020 series of standards addresses a range of different approaches to Environmental labels and declaration and ISO14040- Environmental management – Life cycle assessment. Stated by the ISO, "Environmental labels and declarations provide information about a product or service in terms of its overall environmental character, a specific environmental aspect, or any number of aspects. Purchasers and potential purchasers can use this information in choosing the products or services they desire based on environmental, as well as other, considerations. The provider of the product or service hopes the environmental label or declaration will be effective in influencing the purchasing decision in favour of its product or service" (ISO OBP: 14020:2000). ISO categorizes three types of standard declarations, which are listed in the table below.

Table 3.2: ISO Environmental Declaration Types

Type	Description
Type I (ISO14024)	Ecolabeling schemes Voluntary, multiple-criteria-based, third-party program that awards a license that authorizes the use of environmental labels on products indicating overall environmental preference of a product within a particular product category based on life cycle.
Type II (ISO14021)	Self-declared environmental claims
Type III (ISO 14025)	Life-cycle data declaration Voluntary programs that provide quantified environmental data of a product, under pre-set categories of parameters set by a qualified third party and based on lifecycle assessment (LCA), and verified by that or another qualified third party.

Another certification body within green building is the Scientific Certification Systems (SCS), an organization which provides third-party environmental and sustainability certification, auditing, testing, and standards development (SCS Global, 2016). SCS oversees the FloorScore program, as well as creating and overseeing LCAs, PCRs, EPDs and HPDs.

3.3. Green Building Processes & Systems

As energy use continues to increase, so has interest, research and adoption of green buildings and materials. And while many studies (e.g., Mate 2006, Gale 2011, Hayles 2015) show that most designers agree that sustainable design is the future (90% of those surveyed in the 2006 Mate study), a substantial number of them do not work with GBRS or sustainable materials (less than half (45%) in the Mate (2006) study had value systems that were in keeping with this statement). Further, in a 2011 study of architects, facility managers, and interior designers, Gale observed that 90% of practitioners interviewed in her study had no to limited understanding of certification programs, even though 81% stated they had moderate to good understanding of environmental design strategies (Gale 2011). In a review of current metrics in green buildings, Marjaba & Chidiac (2016) state that not only do LEED and BREEAM not address all areas of sustainability, they also have yet to produce metrics that are repeatable, reproducible, and a true reflection of the building performance. What manufacturers, architects, designers and purchasers require is objective and unbiased environmental information presented in a manner that eases comparisons between similar products (Underwriters Laboratories Inc. 1a 2011).

For many professionals designing built environments, it is a challenge to make a strong connection between material choices and the impacts they may have on the environment. It may be difficult to fully understand "…a material with high embodied energy and the resulting environmental degradation created by the mountain top mining of coal, the production of greenhouse gases, and release of toxic mercury." (Steig 2006). The environmental burdens resulting from design and material choices are large and broad, leading to dozens of considerations architects and designers must make, which are echoed in the dozens of different labels, certifications and databased currently available.

A primary issue in ecolabels related to environmental performance is validity. Kang & Geurin (2009) found that fast and easy access to material data was considered an important factor in material specification and those surveyed were found to rely heavily on manufacturers' literature because of its availability. It has already been established that manufacturers are looking to sell product, so the information they provide may be inaccurate, make false claims, or promise environmental benefits which do not exist (Golden et al. 2010). This is seen with the C2C proprietary clause: companies seeking C2C product certification may choose not to disclose all of the materials or ingredients of a product if they are proprietary. This goes against the whole idea of transparency and disclosure that is central to making informed material choices. Standards in certification length is also an issue with ecolabels: once a product is certified, there is no standard for the length of time the manufacturer is allowed to display the label before reassessment. In the single-attribute category, 45% of labels offer certification that lasts one to two years, 16% of labels last less than one year, and 14% last forever (Golden et al. 2010).

In 2009, Kang et al. investigated the current state of environmentally sustainable interior design through an online survey of American Society of Interior Designers, with 305 completed results. The findings of this study revealed that sustainable interior materials were less frequently applied components of environmentally sustainable interior design than indoor environment quality. It also appeared that interior designers were not aware of environmental issues related to the entire life cycle of interior materials. Two of the processes available for architects and interior designers to address product lifecycle are the C2C certification system and LCAs. Challenges in the adoptability of C2C and LCA approaches are presented in the study *Designing Cradle-to-Cradle Products: A Reality Check* (Bakker et al. 2015). The conclusions of this study are that LCA and C2C can and should be used as complementary tools. C2C is an objective method (physical measurements with repeatable results), but it is deficient in its assessment of global warming potential and it omits certain life cycle phases that are included in an LCA (such as the energy consumption of products) (Bakker et al. 2010). Braungart et al (2007) argue issue of life cycle assessment (LCA) is not ignored by the C2C Institute, rather, the process of C2C does not fit into the LCA approach; "…is an unsuitable approach for generating eco-effective products and processes because its linear nature does not allow for optimization in the context of cradle-to-cradle design." However, it has been suggested that energy consumption during use is responsible for most of the life-cycle impacts of energy-related products (Llorach-Massana et. al. 2015), making the overall environmental preference of the C2C label questionable.

In the Llorach-Massana et al. (2015) study, the authors examined products which had both C2C certification and a completed LCA report. LCA results were analyzed to see if the stages with the highest environmental impact from each product category are the same that C2C requirements address: raw materials and end of life. The two major findings from this research reiterate that the C2C approach does not support a full life-cycle approach, thus a C2C certification do not always reflect the life-cycle distribution of environmental impacts for products. The second conclusion is that there is a direct relationship between energy consumption during use and the increase of the global environmental impact for almost all impact categories. C2C certification, which does not take into account energy intensity, may not be appropriate for products with high energy intensity. In another study analyzing the C2C approach, the authors looked to The Netherlands, as that country began to implement the C2C approach to reduce the environmental impact of buildings in 2008. However, many of the professionals attempting to implement the theory found complex difficulties in adopting the C2C suggesting the concepts and principles are hard to grasp and implement (van Dijk et al., 2014). Many companies involved in the building industry find C2C quite intangible and have difficulties putting it into practice due primarily to the complexity of building projects, complexities which vary from buildings to interiors. Mentioned in Section 2.3 by Bribián et al. 2011 and Yeheyis et al. 2013 often building structures and interior materials are fastened in a way that does not make reuse or recycling a feasible option (especially for interior materials who durability does not make reuse possible).

Golden et al., (2010) recognize the limitations of LCA reports, stating, “Labels that cut across the product life cycle to include the consumer use phase make a lot of assumptions about how consumers will use the product, so the environmental impact assessment of the product is, at best, a guess.” Furthermore, life- cycle information is frequently unavailable, and LCA tools have elicited criticism for not adequately accounting for chemical hazards (Henrik et al. 2007, Niederl-Schmidinger & Narodoslawsky 2008). Looking to navigate through a very complex assessment, designers commonly use streamlined LCA (with single-score assessments), as these require little sustainability expertise and can be executed relatively quickly. The single score gives an (aggregate) indication of the product’s environmental impacts (Bakker et al., 2010).

Buildings, and the materials in them, are complex and multi-faceted, with the end-of-life phase being particularly challenging to model due to the high uncertainty of processes that will occur in the future (Silvestre et al. 2014). However, understanding this end-of-life phase is essential in order to have a complete LCA understanding of the building. Silvestre et al. (2014)conclude that the majority of EPDs only provide one end-of-life scenario and that, despite being informative, they should be complemented by at least one more scenario, preferably concerned with recycling (Silvestre et al., 2014). A 2012 study *by* Hossaini & Hewage explores the emergy (the energy of one kind (usually solar energy) that is used, directly or indirectly, to make a product or service)) in relationship to LCA and LEED systems. The study scope narrows down to the rapidly renewable materials credits in LEED and includes bamboo and linoleum floor materials as study materials. The results show that the rapidly renewable materials, which can be worth credits within LEED, should not be chosen blindly without considering their broader overall environmental impacts (i.e., transportation and material manufacturing may have higher impacts in a renewable material, compared to a non-renewable material). They also surmise that the durability of material (life time) is an essential element of sustainability, since a longer building life span corresponds to lower annual energy inflow for material manufacturing stage (Hossaini & Hewage 2012).

Although there is debate on the actual costs of completing green building rating certifications, as evidenced in Section 3.5, cost is still very much perceived to be a barrier to green design and buildings. In the 2014 study done by Matisoff et al., engineers stated that LEED has reduced costs for higher levels of certification by driving the market, changing norms, and making it easier to pursue certain credits (Matisoff et al. 2014). Much of the additional expense of building green comes from costs associated with the third-party verification process (Mills et al. 2004, D'Antonio 2007, Morris & Matthiessen 2007), a finding that bodes well for those working to see more green interior materials, in that the actual materials themselves do not necessarily cost more.

It is worthwhile to address the other positive attributes of green buildings, outside of strictly environmental impacts, including capital expenditures. Advocates justify green building on operating cost reductions in water, wastewater, and energy expenditures (hard cost benefits), and improved performance of building occupants (soft cost benefits) (Hoffman & Henn 2008). This improved performance, health, and happiness of building occupants has been documented in numerous studies (e.g., Hoffman & Henn 2008 Kang & Guerin 2009). Healthy indoor environments can increase employee health, which, in turn, can increase their productivity. This has a tremendous effect on overall employer costs, as workers are the largest expense for most companies (Kang & Guerin, 2009): one study saw an increase in occupant performance in green buildings by 6% - 26% (Hoffman & Henn, 2008). Also, rental and sales premiums tend to increase with GBRS certification (Eichholtz et al. 2010b).

3.4. Transparency Movement

The push for manufacturers to disclose the ingredients, chemicals, human and environmental impacts of their products has never been stronger, and with EPDs and HPDs now earning credits in GBRS, their use will likely rise. This push is coming from professionals (architects, interior designers, engineers, etc.), and also organizations concerned with human and environmental health. Many manufacturers are responding and providing more information on their products, however the issue of disclosure is conflictive at best. The goal of a manufacturer is to sell products, so most are unlikely or reluctant to disclose the harmful or hazardous aspects of the material or product (Cargo 2013). As stated by Atlee & Melton (2014b), the transparency movement is important, but "transparency is not the same as performance", and comparability is paramount. Reception to ingredient disclosure has not been universally positive, in part because the credits available in GBRS, especially LEED, may reward transparency without regard to the product's actual environmental performance. A polluting or high-emitting product could in theory earn the project LEED green material credits if the manufacturer has released a life-cycle assessment or EPD (Atlee & Melton 2014).

3.5. Barriers to designing/specifying

The area of barriers to sustainable design has been widely studied in the past 15 years, with the largest barrier to greater implementation of green building strategies and materials most often being cost (Mate 2006, Matthiessen & Morris 2007, Hoffman & Henn, 2008, Kang & Guerin, 2009, Ahn et al. 2013, Bakker et al., 2015, Hayles, 2015). However, most recent research debunks the perception that green building costs more, and certainly not to the level of capital costs that most architects and designers perceive. This is not to say that green buildings, especially certified ones, did not in the past, cost more to design and construct. Recent studies have suggested though that these capital cost premiums are coming down. A study by Davis Langdon concluded that "…many projects are achieving LEED within their budgets, and in the same cost range as non-LEED projects" and in a 2016 study by Dwaikat & Ali, who looked at 17 empirical studies on green cost premiums, no consensus on a premium of green building could be reached, however "…the reported green cost premiums through empirical investigations fall within a range from −0.4% to 21%." (Dwaikat & Ali 2016).

The cost barrier is wide: cost of certification, time to research new sustainable technologies and materials, a premium for green materials, and supply and demand for experienced trades (Hankinson & Breytenbach, 2013). Typically, the costs of learning new forms of green design are not billable to the client. With fixed resources, team members must invest in this learning process, but often at the cost of some other activity critical to their job (Hoffman & Henn, 2008). However, Mate (2009) divides the cost barrier into two practitioner categories: those who are proactive in sustainable design, and those who are not. The cost of using sustainable materials was not a significant barrier for those who were proactive in sustainable practice, yet for those who were not ready to take responsibility for sustainable practice or who followed sustainable practice only when required, cost was considered the biggest barrier (Mate 2009). In a similar study exploring the drivers and barriers to green design, Ahn et al. (2013), identify the largest barriers to sustainable design to be cost premium of the project, long pay back periods from sustainable practices, tendency to maintain current practices, and limited knowledge and skills of subcontractors.

Few architects, interior designers, or specifiers have the time or expertise to engage in toxicology debates, and the design community has had little guidance on how to practically implement the precautionary principle in addressing emerging chemical concerns (Atlee 2011). As the green building movement continues to increase, those who lag in knowledge, education, and/or motivation in relation to sustainable design will likely begin to be isolated. Hoffman & Henn (2008) discuss, “Green building also adds a new set of technical terminology regarding material selection. However, this terminology requires a new knowledge base (and) quickly identifying participants who aren’t yet embedded in the green construction industry”. Further, becoming an expert in green building is often overshadowed by more pressing concerns of managing existing workloads (Hoffman & Henn 2008), leaving little time for researching new materials and technologies.

Although in many studies the client has been presented to be a barrier to implementation of green design (e.g., Mate 2006, Kang 2009b, Ahn et al. 2013) Lam et al. (2010) suggest that it may be a client’s risk averseness to using green materials that is the issue. Reducing the anxiety associated with choosing sustainable materials would therefore increase the use of them. Lam et al. have identified that involvement by the stakeholders should be the most important factor for the preparation of green specifications in organizations. In the 2013 study, Ahn et al. identify the client (and/or building owners and developers) as a major obstacle in sustainable design and construction. This client-based barrier correlates to the perceived cost premium of a sustainable building and the lack of knowledge related to the benefits of sustainable design and construction.

Furthermore, Ahn et al., (2013) specifically identifies barriers to green materials within the sustainable building industry, including a lack of familiarity with green products, limited supply of green products, high cost for green products, and lack of trust or unproven quality of green materials and products. Halyes (2015), with the Institute of Sustainable Practice, Innovation and Resource Effectiveness (INSPIRE) at the University of Wales, identifies specific barriers to green material adoption. After cost, she observes that lack of expertise and knowledge of materials, limited materials selection and authenticity of suppliers, time to source materials, understanding of the impact of materials, accurate and accessible information, and appropriate tools have all been nominated as barriers.

Atlee (2011) also identifies many of the challenges professionals face in the actual procurement of greener materials. Among these challenges are choosing what level of priority and attention to give to minimizing chemical hazards relative to other life-cycle impacts of buildings and building materials, determining what is in a product (let alone what hazards may be emitted during a product's full life-cycle), and determining what chemicals are to be avoided. In Hankinson and Breytabace's (2012) study three concerns were raised when considering the specification of sustainable materials: the reliability of information from product suppliers and manufacturers (e.g., green washing); limited selection of environmentally responsible materials; and the need to rely on imported materials (with high embodied energy due to transportation) versus locally produced materials.

In her 2009 study, Mate observes that most interior designers, including those who view themselves as proactive in sustainable practice, show a lack of confidence in their own knowledge, as well as in the information about the material provided by suppliers. This is supported by Mate (2006), in which 25% of respondents felt somewhat confident in sustainable design (75% were unsure or lacking confidence), leading Mate to summarize that designers, "…are aware that keeping their sustainability knowledge up-to-date involves dealing with a rapidly expanding information base. Hence this group's insecurity about making educated decisions." (Mate 2006).

3.6. Motivators

There have been numerous studies conducted into determining the major barriers in sustainable design, but much less work has been done investigating the motivators for green design. One of these studies, conducted by Lee et al. (2013), uses the Theory of Planned Behaviour (TPB) as a theoretical framework for the research into sustainable design. Less et al. used TPB (developed in the field of social psychology) as it provides one of the most established and well-used theories in the context of environmental behavior. Interior designers in the United States were surveyed on sustainable floor materials. The results demonstrate that three TPB factors (attitude, subjective norms, and perceived behavioral control) are significant determinants of interior designers' behavioral intention to choose sustainable flooring materials.

Table 3.3: Summary of Lee et al. (2013) findings related to TPB and sustainable material selection.

TPB Factor	Summary of findings
Attitude	Interior designers' positive attitude toward the adoption of sustainable materials leads to their stronger behavioral intention to adopt sustainable materials. The results suggest the importance of developing interior designers' positive environmental attitude.
Subjective Norms	The perceived social pressure on interior designers to adopt sustainable materials had a significant effect on their intention to adopt it.
Perceived Behavioral Control	The perceived ease or difficulty of adopting sustainable materials is essential in determining whether or not interior designers will exhibit sustainable choice behavior; sustainable practice would be promoted when they perceived that adopting sustainable material would be easy because they believed they had easy access to information, knowledge, skills, funding, and resources.

A further finding from this study was the value interior designers placed on environmental health compared to human health. Interior designer beliefs about health outcomes did not significantly affect their attitude toward adoption of sustainable materials, whereas there was a significant, positive relationship between their beliefs about environmental outcomes and their attitude toward sustainable material adoption (Lee, E., et. al., 2013). Ahn et al. (2013) identify the most important drivers of sustainable design as energy conservation, which connects to the push from GBRS to reduce overall energy use, improving indoor environmental quality, environmental/resource conservation, and waste reduction.

Another study exploring the relationship of interior designer characteristics and sustainable design used an internet-based survey, and was sent to members of the

American Society of Interior Designers (Kang & Guerin, 2009). Their conclusions include that interior designer characteristics were related to how often interior designers applied environmentally sustainable interior design to their projects, findings which are supported by the Lee et al. study which identified attitude as an important factor. Kang & Guerin also conclude that the larger the project size, the more likely of environmental design strategies and materials implementation. These findings are aligned to the barrier of education or knowledge, discussed in Section 3.5

3.7. Ethics in Design and Sustainability

As attention increases on the global issues facing us all, so do the ethical imperatives for those who help to create the buildings that use so very much of the earth's natural resources and energy and contribute to global warming. Stieg (2006) argues that designers should understand the impact of their activities and take responsibility for their actions. Though ethics are required to be taught in undergraduate degrees in both architecture and interior design across Canada, and are included in the mission of both licensing bodies (OAA and ARIDO), the boundaries of the ethics debate remain murky (should sustainable design be mandatory? Is green design a call to action for all building professionals? Shouldn't sustainable buildings and interior be accessible to all, regardless of scale and budget?). Sustainable design has been called for as an ethical responsibility as well as to demonstrate the value of (interior) design as a profession to society (Anderson et al. 2007, Gurel 2010). As Tom Russ (2010) writes in the book *Sustainability and Design Ethics*, "Questions about consequentialist ethics usually deal with concerns about who the outcome is good for. Should consequences be considered for all or for just the actor?" (p.48). Stephen Loo (2013), contributor to the book *Design and Ethics: Reflections on Practice*, writes, "We often hear that the design profession is constantly falling short of their ethical mission, in the wake of their neglect" (p. 11). Table 3.4 lists the ethical codes for licenced and practising architects and interior designers in Ontario; both associations require members to demonstrate respect to the environment, with the ARIDO code of ethics including specifically sustainability an energy use.

Table 3.4: Environmental code of ethics related for OAA and ARIDO members

Professional Association	Code of Ethics related to the Environment
Ontario Association of Architects (OAA)	Architects with demonstrate respect for the natural and cultural environments of the people and places that are influenced by their work.
Association of Registered Interior Designers of Ontario (ARIDO)	- A Member shall have proper regard for the natural environment in the Member's work. - A Member shall in the course of the Member's approach to the design of any project show awareness and sensitivity to the environment, ergonomics, sustainability and energy use.

Although ethics, and ethics related to responsible design is part of both licensed and practising architects and interior designers in Ontario, it remains unclear as to whether this leads to stronger ethical decisions in sustainable design or energy reduction of an entire building, or environmentally responsible material and finish selections.

3.8. The Role of Psychology in Sustainable Design

There have been many studies done in the recent years which aim to research and analyze the preferences, biases, barriers and limitations of designers specifying environmentally preferred products for the built environment (e.g., Kang et al. 2009, Cargo 2013, Hankinson et al. 2013, Hayles 2015, Sörqvist et al. 2015), with psychology being a focus of sustainable design as well. As discussed in Section 3.6, Lee et al. (2013) present sustainable design behaviour within the Theory of Planned Behaviour (TPB), and Hoffman & Henn (2008) present an observation that many obstacles when building green are not technical or economic, but rather are social and psychological. They point out that most people use unconscious biases when making decision. These are referred to as simplifying strategy, or cognitive heuristics, and a summary of the six identified biases have been included in Table 3.5.

In the Hofmman & Henn (2008) case that generated the observation, law students at a large U.S. university who pressed their administrators to build the new law building as a LEED certified structure were met with huge resistance, even after research was conducted to respond to the administrator's long list of concerns. It was then determined that if all of the economic concerns had been disproven, there were other obstacles (i.e., biases) in the refusal to build green. Of particular interest here is the bias of “overdiscounting the future,” which they explain in relationship to green design: “One cause of the resistance to making wise long-term decisions on energy efficiency is the simple failure to calculate and then make decisions based on payback periods.” In the Hoffman & Henn instance, it is the building occupant who is subject to this subconscious bias, but it’s possible that designers and architects suffer from the same bias, especially as cost is often perceived as the major barrier to specifying green materials (Mate 2006, Matthiessen & Morris 2007, Kang & Guerin, 2009, Ahn et al. 2013, Bakker et al., 2015, Hayles, 2015).

Table 3.5: Summary of results from Hoffman & Henn (2008), identifying subconscious decision making biases.

Bias	**Definition**	**Example in sustainable design**
Overdiscounting the future	Consumers use high discount rate when purchasing	Underinsulating homes, purchasing energy inefficient appliances.
Egocentrism	People make self-serving judgement of what is fair; decisions made an individual level appear fair, but are contrary at aggregate level	Purchasing land/home in suburban sprawl for large yard
Positive Illusions	Tendency for people/organizations to see themselves, the world and future in better condition than it is, or will be	Environmentally responsible behaviour is weak in reality; project their virtue
Presumed Associations	Mistakenly correlating two events or the likelihood to two events	Many continue to see the environmental movement as hippie culture. Environmental building may have poor function (i.e., water pressure)
Mythical fixed-pie bias	Assumption that economic and environmental interests directly oppose each other	Decision makers overestimate the true costs of building green, i.e., a green building always costs more

Table 3.5 Continued: Summary of results from Hoffman & Henn (2008), identifying subconscious decision making biases.

Environmental Literacy	Lack of literacy of environmental issues	Exacerbates all previous biases in lack of information and understanding

Another important psychological aspect of green design is introduced by Sörqvist et al. (2015). These authors introduce the term *ecolabel effect*: a preference bias for ecolabeled products. This preference for products that are perceived to be environmentally superior encourages the purchase of products that are less environmentally harmful, and also skews the perception and performance of these products, as evaluations are more positive and products are idealized (Sörqvist et al. 2015). This study on lighting was the first to demonstrate that a product with an ecolabel (or otherwise positive environmental attributes) can affect the participants' feelings of comfort and building performance. It can be argued that the ecolabel effect could play a significant role in both the specifier's selection of environmentally preferred interior materials, as well as in the building performance and comfort for the occupants. Whether it applies to the architects, designers, and project specifiers, those who choose materials on their client's behalf, is a question looking to be answered in future academic research.

3.9. Summary of Literature Review

Chapter 3 presents the current academic and professional studies on green building systems, resources and tools from a broad spectrum of approaches. The first section identifies ecolabels, their benefits and limitations. One of the most addressed limitations to the ecolabels is the validity in their claims (with the ISO standards thought by many to have the highest authority), and, when lack of time to research is identified as a barrier to sustainable material specification, professionals have little time to validate a claim. Though the first-, second- and third-party labels aim to categorize, it remains unclear as to whether architects and designers have a working knowledge of these differentials:

some could take any label as indicating it as environmentally preferable when the material is not.

There is a strong call for material ingredient transparency coming from organizations and GBRS, to prevent materials heavily loaded with toxins and chemicals with adverse environmental and health impacts. Reflecting this growing trend, EPDs, C2C, Declare and Transparency, though it appears little research has been conducted into the use of these tools for architects and interior designers. Two of the most commonly studied ecolabels and methods to date are the C2C label and the LCA methodology. The inclusion of the LCA approach into LEED v4 and Green Globes, as well as C2C in LEED v4 echoes the growing interest in systems and tools, but the literature also can be summarized in that no label or resource is flawless, or should be used for all materials. There are limitations to all GBRS, ecolabels and product certification systems, but in order to understand said limitations, and find solutions to them, one would need to dedicate a significant amount of time and interest. This will be explored in the web-based survey.

Barriers and motivators were studied as part of the literature review, with cost most often concluded to be the biggest obstacle to green design, However, many study authors suggest that this is a perceived cost, and for those who have experience in green design, cost is rarely identified as a barrier. Education and training, or lack thereof, has been identified as another significant barrier, which can be also related to the cost and training relationship: most architects and interior designers work on billable hours, and so may not be able to bill their clients the time needed to research sustainable material alternatives, the updates within GBRS or the newest ecolabel or database. The cost for this would often fall onto the practitioners themselves. The literature also states that clients not requesting sustainable design (and the perceived risks to it), are also a barrier, as is the overall confusion in the world of green building products, technologies and solutions. The overall environmental motivator from the studies was energy conservation, yet the psychological/behavioural motivators into sustainable design have also been studied. A positive attitude toward environmentally responsible design proved to be a large motivator, followed by pressure and available ease of accessing information. It is interesting to note that the majority of studies on sustainable materials and design barriers and motivators were focused on interior designers; no studies on architect's behaviour, barriers and motivations related to sustainable design, architecture or materials could be found.

The three most important takeaways from the literature on current rating systems, tools, processes, and resources are:

1. Cost is perceived to be the largest barrier to overall sustainable design and green material adoption, supported by research that has studied barriers to environmentally responsible design (Mate 2006, Matthiessen & Morris 2007, Hoffman & Henn, 2008, Kang & Guerin, 2009, Ahn et al. 2013, Bakker et al., 2015, Hayles, 2015). The cost barrier, which has been suggested as a perceived barrier by Langdon (2007) and Dwaikat & Ali (2016), includes several different components: the cost to certify from an education and administrative perspective, cost to research, and a perceived cost premium for green materials. Mate (2009) suggests that a cost premium (perceived or not) for those professionals who are engaged and experienced in practicing sustainable design is not a barrier. Given that cost is a consistent and large obstacle in the area of green buildings, the scope of the research in this study is on factors beyond cost that influence the degree to which architects and interior designers specify green interior materials.
2. The importance of understanding the psychological, behavioural, and social aspects of architects and interior designers to encourage stronger uptake of sustainable design solutions (which becomes then an opportunity for education). Research shows that the professionals must first care about the issues related to sustainability and the built environment, but also that most act in accordance with social norms (i.e., if a client, co-worker or superior feels very strongly about environmentally responsible design, there is a greater likelihood of the individual selecting solutions and materials that are environmentally responsible). This information is extremely important to the organizations that create and manage the rating systems, tools, and resources, as well as the product manufacturers.

3. A common theme throughout the literature is the inaccessibility of the current GBRS, ecolabels, methodologies and resources. Both architects and interior designers work with demanding schedules, restricted budgets and high-pressure deadlines, so looking through a 50-page LCA, 15-page EPD, or comparing product labels are all barriers to the use of specification processes for environmentally preferred materials. The complexities of some of the rating systems and labels are not aligned with the education and experience of architects and interior designers, making them very challenging to understand and implement.

4. Chapter V- Methods

One of my goals with this study was to gain greater knowledge of the green building movement in Ontario, in an attempt to have a snapshot of the current state of sustainable interior materials. The objectives of this survey was to identify the number of architects and interior designers who have sustainable design training or designation to compare with experience working with GBRS and ecolabels, to understand the hierarchy of environmental factors when specifying sustainable materials, and the overall adoption of current resources and decision making processes.

4.1. Geographic Scope

The geographic scope for this research was limited to Ontario, Canada. Not only is this where I live, practice and teach, but also has a large population of both architects and interior designers. Both professional organizations, the OAA (Ontario Association of Architects), and ARIDO (Association of Registered Interior Designers of Ontario), have professional memberships and designations, so members of these two organizations became the target audience for the survey. As mentioned in the research background, Ontario is a large catchment for both architects and designers: of the 4,753 architects listed in the members directory of the Royal Architectural Institute of Canada (RAIC), 2,028 are registered in Ontario (43%), and of the 3,174 registered interior designers with IDC (Interior Designers of Canada), 1,802 are within Ontario (57%).

4.2. Data Collection Method

A quantitative approach was used (web-based survey) to gain insights into the questions this study proposed, and was executed through the following steps: survey design and ORE approval, email list generation, email invitation, follow-up invitation, data collection and analysis.

A web-based survey questionnaire was created targeting OAA and IDC- Ontario members. It was designed to require minimal investment of time for participants, while allowing a large survey population to be contacted simultaneously. Appreciating that both architects and interior designers have full and demanding schedules, the 28-question survey was designed to take approximately 10 minutes to complete. The survey included multiple-choice questions, scale, and ranking questions, while also providing respondents the opportunity to add open-ended explanatory comments if they desired. After review and feedback from the UW Survey Research Centre, questions were designed to be simple, straight-forward, and concisely worded.

The survey instrument (contained in Appendix B5) was slightly modified for each group: the professional identifying terminology in the first three questions was based on profession, and the subject line of the email inviting participation was changed. As a number of OAA members are graduates of University of Waterloo's School of Architecture, the subject line for the OAA survey invitation was, "UW Research: Sustainable Materials." Including UW in the subject line was intended to encourage OAA graduates to support their alma mater, and "interior" was not used until the email body, to minimize the impression among architects that the email was not intended for them. The subject line for the email to invite interior designers to participate was "Research: Sustainable Interior Materials"; UW was omitted, as it would not hold any significant value to most all interior designers, and "interior" was included, to align to the field of practice for this group of recipients.

As of January 2, 2016, there were 3747 licensed architects listed on the OAA website (www.oaa.on.ca), under the "Discover an Architect" tab. As part of the parameters of this research, and to ensure all survey participants were currently practicing, only "architects" were selected from the search category, while the following titles were omitted from the OAA site search when selecting survey invitation recipients: Intern, Honorary Architect, Licensed Technician OAA, Life Member, Retired Member, and Student Architect. From the full list of 3747 architects, 1,621 have publically available email addresses under their profile. As of January 2, 2016, 1,046 registered interior designers were listed in the designer directory on the ARIDO website, while there were 1,802 published in the Ontario section of the IDC (Interior Designers of Canada) printed directory (interior designers must be licensed to gain membership into either organization; it is assumed the higher membership rate for the national organization is due to greater organizational benefits). The recipient list for interior designers was created using the IDC- Ontario chapter, chosen to gain the highest number of possible participants. Each email address was manually input into a spreadsheet that was then imported into the Mailman email mass subscription for distribution. No identifying data were associated with the email addresses in order to ensure confidentiality.

The deployment of the email invitations presented quite a challenge. In consultation with the IT department at the University of Waterloo, a 'mailman' subscription list was chosen as the optimal solution for this problem. Consequently, two mailman lists were created by the IT department; one for OAA members and one for ARIDO members. Two email invitations were sent to both groups using the mailman list platform, the first being sent on Wednesday, April 13, 2016 and the second (reminder) email was sent the following Wednesday, April 20, 2016. The reminder email saw a spike in survey participation from both groups, resulting in higher survey participation and completion than from the initial email. The survey closed 10 days after the second reminder email, on Sunday, May 2 at 11:59p.m., to provide more than one week for completion, recognizing the demanding schedules of architects and interior designers.

4.3. Limitations

This study addresses the environmental impacts of interior materials from the professional viewpoint of architects and interior designers in Ontario, as such, there were limitations to the study which are listed below:

Limitations of sample size: In order to scale the number of invited survey participants, and keep the study results relevant for the author, only architects and interior designers who are licensed in Ontario were invited to participate in this study. Fortunately, with a total of 242 beginning the survey and 153 completed it (63%), the sample size was large enough to support valid and mealingful results and conclusions. However, a limitation to making broad conclusions is the geographical limitation of practitioners only being from Ontario.

Self-selection bias: In order to create an unbiased survey participant list, all architects and interior designers listed with OAA and IDC-Ontario were invited to participate in the web-based survey, not only those who specialize in sustainable/green design. However, the subject line of the email invitation included “sustainable materials”, so based on self-selection bias, it can be hypothesized that some respondents to the survey have an interest or awareness of environmental design and/or sustainable materials. Further, it is acknowledged the self-selection bias could lead to respondents elaborate some of their survey results.

LEED Designation clarity: Survey participants were asked to identify if they had any, “green building/ sustainable design trainings or designations”, and if so, to please identify. The majority of the respondents (87%) who stated “yes” to training or designation were LEED accredited. However, respondents were not asked to identify which category of LEED they are accredited in (Building Design and Construction (BD&C), Interior Design & Construction (ID&C), Building Operations and Maintenance (BO&M), Neighbourhood Development (ND) or Homes). This verification could have led to interesting insights into the differences of sustainable material experience and selection behaviour with those working with LEED BD&C (presumably more architects) compared to those working with LEED ID&C (presumably more interior designers).

It is also recognized that many buildings are designed without an architect or interior designer (however the data on the percentage of building could not be found). The scope of this study, however, was to understand the current state of GBRS and sustainable materials through the lens of architects and designers, not to snapshot the state of GBRS and sustainable materials in all buildings. As such, the conclusions of this study cannot be stated to address all buildings.

4.4. Analysis Methods

Upon survey closure, the analysis was executed through the following steps: data input, exploratory analysis, data plotting, architect and interior designer result comparisons.

The survey data was collected from the FluidSurvey platform, and although FluidSurvey creates charts based on the responses, the raw data was exported into spreadsheets for further analysis. With the raw data compiled by each respondent, each architect and interior designer was given a generic identification code allow for deeper analysis of the data while preserving anonymity: architects who began the survey (i.e. - clicked, “I agree to participate in this study”) were coded “AR1, AR2, AR3….AR119”, and interior designers who began the survey were coded “ID1, ID2, ID3…ID123”. Data from these subjects proved to be diverse in the amount of experience, training and education respondents had relating to sustainable design, allowing for the study questions to be answered.

4.5. Organizational Table:

With the survey consisting of 28 questions, the data, results and interpretations are immense, and could be looked at from many different contexts. In order to assist in presenting the results in an accessible format, Table 4.1 below visually identifies the major comparative responses of the results from the web-based survey, with the aim to assist the reader in understanding an overview of the survey results.
Some of the primary objectives of this study included exploring the relationship between architects and interior designers with green building certification/training and their adoption of green building materials, with the use of the most common tools and resources. Thesis issues are explored in Question 4, *6, 18, 20, 22 and 25.*

The general use of current green building decision making processes by survey respondents is another important observation from this study, with Questions 9, 10, 11, 12, 13, 16, 18, 20, 22, 25 and 28 addressing the overall adoption. Finally, the alignment of the environmental values of architects and interior, and how these align to the systems, tools and resources, is another critical outcome from this study, and is included in Questions 7, 8, 9, 12, 13, 14, 15, 16 and 28.

Table 4.1: Organization of Survey Results and Comparisons

Question	Comparative References
Q4. Professional green training/certifications	• Q5 (Percentage of projects certified green over 2 years)
Q5. Percentage of projects certified green over 2 years	• Q6 (Percentage of interior materials certified green over 2 years)
Q6- Percentage of interior materials certified green over 2 years	• Q4(Professional green training/certifications) • Q5 (Percentage of projects certified green over 2 years)
Q7: Green design request from client	• Q5 (Percentage of projects certified green over 2 years)
Q8: Primary motivator to specifying green materials	N/A
Q9: Resources used to source green materials	• Q4(Professional green training/certifications) • Q8 (Primary motivator to specifying green materials)
Q10: Important label/documentation when specifying green materials	• Q4(Professional green training/certifications) • Q16 (Importance of material ingredient disclosure) • Q18 (Experience with LEED v4 MR credits) • Q20 (Experience with C2C) • Q22 (Experience with EPD) • Q24 (EPD relevancy in green material specification) • Q25 (Experience with LCA) • Q27 (LCA relevancy in green material specification)
Q11: Ecolabel most often included in specifications	• Q4(Professional green training/certifications)
Q12: Why ecolabel most often utilized	N/A

Table 4.1 Continued: Organization of Survey Results and Comparisons

Question	Comparative References
Q13: Important factor when selecting green material without ecolabel	• Q4(Professional green training/certifications) • Q10: Important label/documentation when specifying green materials • Q11 (Ecolabel most often included in specifications) • Q12 (Why ecolabel most often utilized)
Q14: Professional rank of environmental factors	• Q4(Professional green training/certifications) • Q12 (Why ecolabel most often utilized) • Q13 (Important factor when selecting green material without ecolabel)
Q15: Client rank of environmental factors	• Q7 (Green design request from client) • Q8 (Primary motivator to specifying green materials) • Q13 (Important factor when selecting green material without ecolabel) • Q14 (Professional rank of environmental factors)
Q16: Importance of material ingredient disclosure	• Q4(Professional green training/certifications) • Q10: Important label/documentation when specifying • Q17 (Material ingredients avoided)
Q17: Material ingredients avoided	N/A
Q18: Experience with LEED v4 MR credits	• Q4(Professional green training/certifications)
Q19: Most often used LEED v4 MR credits	• Q4(Professional green training/certifications) • Q16 (Importance of material ingredient disclosure) Q18 (Experience with LEED v4 MR credits)
Q20: Experience with C2C	• Q19 (Most often used LEED v4 MR credits)

Table 4.1 Continued: Organization of Survey Results and Comparisons

Question	Comparative References
Q21: Barriers to C2C	• Q15 (Client rank of environmental factors) • Q19 (Most often used LEED v4 MR credits • Q20 (Experience with C2C)
Q22: Experience with EPD	• Q4(Professional green training/certifications • Q10: Important label/documentation when specifying green materials • Q19 (Most often used LEED v4 MR credits)
Q23: Barriers to EPD	• Q21 (Barriers to C2C)
Q24: EPD relevancy in green material specification	• Q4(Professional green training/certifications) • Q22 (Experience with EPD) •
Q25:Experience with LCA	• Q4(Professional green training/certifications) • Q19 (Most often used LEED v4 MR credits • Q24 (EPD relevancy in green material specification)
Q26: Barriers to LCA	• Q19 (Most often used LEED v4 MR credits
Q27: LCA relevancy in green material specification	• Q26 (Barriers to LCA)
Q28: Biggest barrier to green material specification	• Q6 (Percentage of interior materials certified green over 2 years) • Q7 (Green design request from client) • Q8 (Primary motivator to specifying green materials)

5. Chapter VI- Results & Discussion

This chapter provides a summary of the response rates for the web-based survey sent to licensed architects and registered interior designers in Ontario, as well as the survey results. The results are presented in chart format for each question, and also discussed within the context of the study scope and objectives; analysis of the respondents was done in order to understand the broader implications of the answers. Interpretations are also included for each question, identifying themes, correlations and disconnects, threading together the results to form a cohesive set of observations and conclusions.

5.1. Response Rates

The response rate for the web-based the surveys are presented below, in Table 5.1. The number of respondents who clicked on the link and began the survey (i.e., clicked “I agree to participate in this study”), averaged 7%. Of those who began the survey, 61% of architects and 66% of interior designers completed it; given the length of the survey, 28 questions, this response rate is considered to be adequate, creating a strong set of data for interpretation and analysis. Further, the survey was designed to take an average of 10 minutes to complete, so the completion time for respondents (11:34 minutes for architects, 14:34 mins for interior designers), indicates time and thought was put into the responses.

Before beginning the survey, all participants were required to consent to the terms of the study by clicking on the “I agree to participate in this study” checkbox. Five of the 119 architects and 4 of the 123 interior designers did not agree to participate in the study. Of the 101 architects who began the survey, 69 “completed” it, or made it to Question 28; 55 of 101 architects responded to Questions 15 through 27. One hundred and nineteen interior designers agreed to the study, 105 started it, and 81 “completed” it. The question with the lowest participation response was Question 16, “Are there interior material ingredient(s) that you avoid due to adverse environmental impacts?” with 75 of 119 responding.

Table 5.1: Survey response rates

Participant Group	Sent	Began	Open rate	Completed	Completion Rate	Time
OAA Members	1,621	119	7.3%	72	61%	11:34
IDC- Ontario Chapter Members	1,802	123	6.8%	81	66%	14:34

5.2. Survey Results & Interpretations

The first page of the survey provided information on the study, where the participant's name and email were collected from, the study's objectives, as well as the ethical clearance from the Office of Research & Ethics (ORE) (See Appendix B5 for the full survey instrument).

- **Question 1**- "*Please indicate the size of architecture/design firm where you are currently employed*"

Of the responses, the highest percentage of both architects (34 of 119, or 29%) and interior designers (31 of 123, or 25%) who responded to the survey are employed with small firms (between 2-10 full-time employees), with a significant number of architects and interior designers being self-employed (n=20 and n=26, respectively) as seen in Figure 5.1. This question will help provide insight into whether there is a correlation between design firm size and a) professional green design credentials (with cost being assumed to be a barrier to green training), and b) the amount of sustainable materials specified.

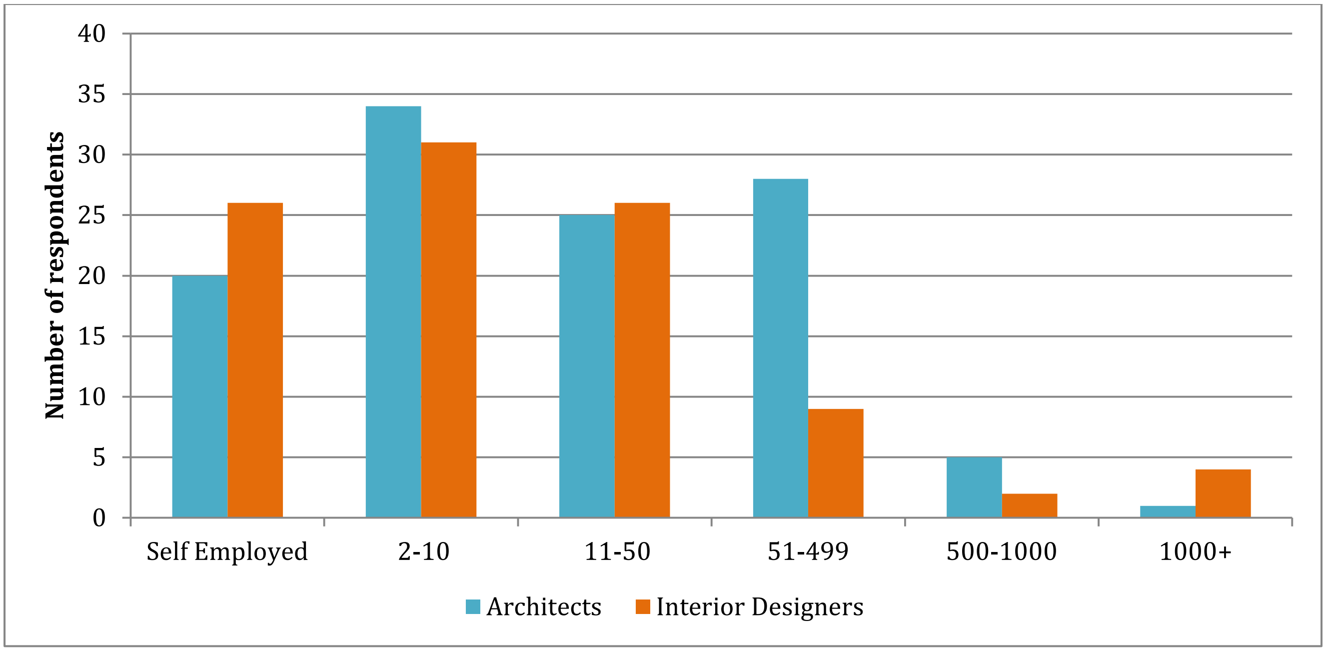

Figure 5.1: Size of firm (full-time employees)

- **Question 2**- "*What category of the built environment do you work in?"*

The two most common fields of work for architects in this study were residential (n=30) and commercial (n=25). The "other" category also had 30 respondents, with architects listing a number of different categories: 16 of the 30 responses were a combination of the listed categories (i.e., they selected more than one category). Two (2%) of the architects answered "green design" as their speciality, while three (3%) indicated "heritage." The highest response number of the interior designers (n=41), work in commercial design, with 26% (n=27) specializing in residential. Within the "other" category, 55% (n=11) of the "other" interior designers work in a combination or all of the categories, 20% (n=4) work in retail, while no designer specified "green" as their primary field. The healthcare, educational, and hospitality categories had small numbers of responses from both architects and interior designers, (7%, 8%, 1%, for architects and 7%, 3%, 5% for interior designers, respectively). Kang & Guerin (2009) state that "…designers specializing in child care and educational facilities most often used sustainable interior design practices. Other specialties, in descending order, were hospitality/entertainment, financial institutions, health care, government/institutional, corporate/office, residential, and retail design.” This is of interest, as education and healthcare are typically the category of interiors that require the most rigorous in green design. If the responding participants worked primarily in healthcare or education, the results may have indicated both stronger green design experience and understanding of sustainable design processes. An attempt to compare the category proportions of survey respondents to the proportions of OAA, IDC-Ontario and ARIDO members was not successful, so a representative conclusion cannot be made.

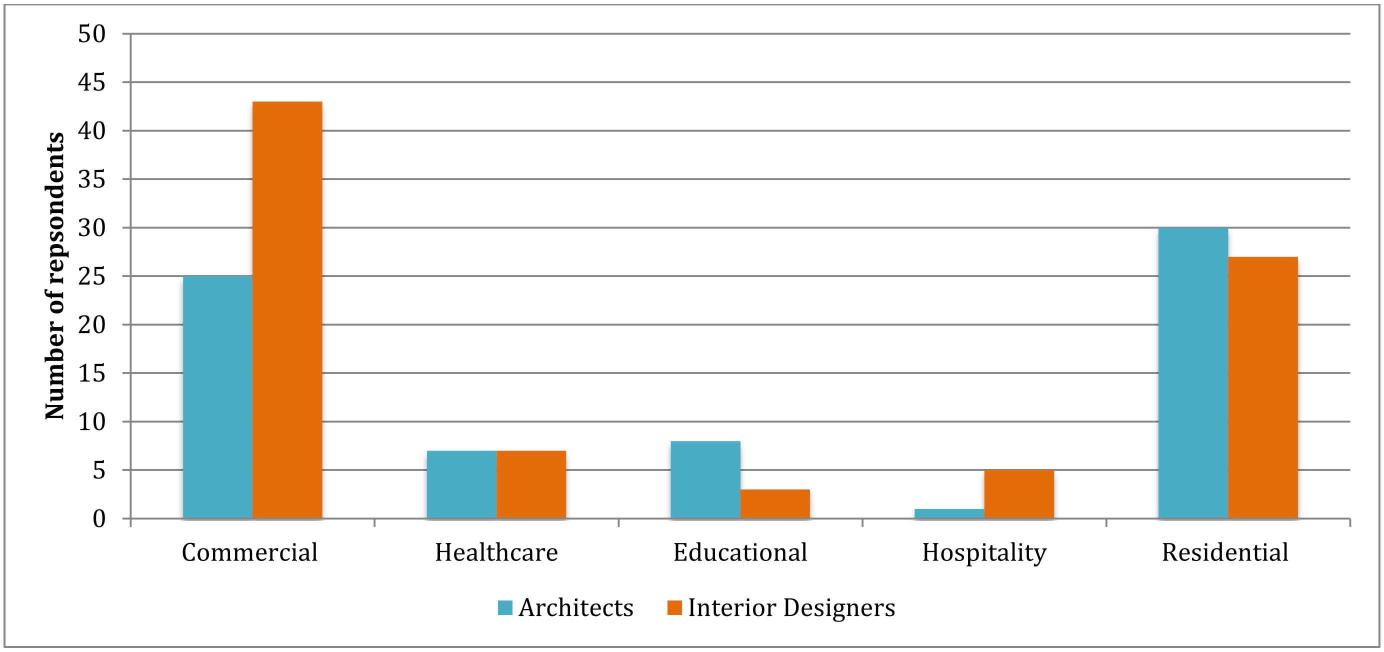

Figure 5.2: Architects and Interior Designers field of specialization

A search into the profiles of LEED certified buildings in Canada was done by the author, with the results showing that ‘office buildings’ (n=1267), ‘commercial interiors’ (n=748) and ‘LEED homes’ (n=630) had the highest overall number of certified projects, while schools and healthcare facilities had the least. This illustrates a similar pattern to responses for architects’ and interior designers’ speciality fields.

- **Question 3:** *“How many years’ experience do you have working as a licensed architect:/interior designer?”*

The years of work experience for survey respondents varied across all four categories (Figure 5.3), with the highest number of architects (34%) and interior designers (33%), having 25+ years of experience. The results from this question are interesting given that sustainable design is now taught in both architecture and interior design undergraduate degree programs, and so it may have been assumed that more of the younger graduates would have had education, more interest and awareness into sustainable design and therefore more motivation to complete the survey.

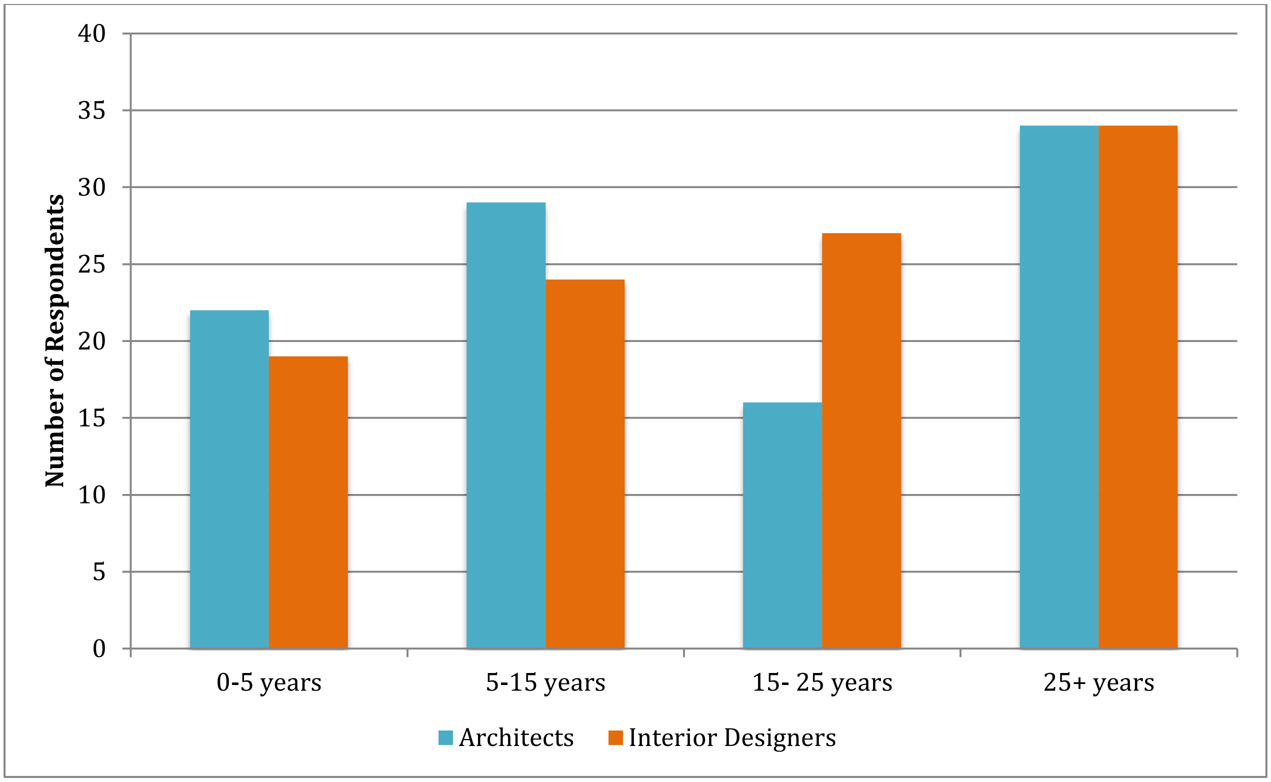

Figure 5.3: Years work experience

- **Question 4**: *"Do you have any green building/ sustainable design trainings or designations?"*

Half of all survey participants declared they had a green building or sustainable design designation (56% of architects, and 44% of interior designers), as shown in Figure 5.4, with the type of designations illustrated in Figure 5.5. Of the 57 architects who responded "yes" to having trainings or certifications, 77% (n=44) of those were LEED accredited, 7% (n=4) had some Passive House training, 4%(n=2) had Green Globes certification, and 2% (n=1) each were trained under LBC and BREEAM. Many architects had more than one certification (AR10- Green Globes, BREEAM, LEED: AR34- Green Globes AP, LEED AP, Living Building Challenge, AR56- LEED, PassivHaus, AR60- LEED, AP, EnerGuide, R2000, GS

Ecodesigner certified). Of the 46 interior designers with green building certification or designations, 78% (n=36) are LEED accredited, 2% (n=1) is LBC and 20% (n=9) included responses did not have recognizable designations, based on the scope of this study (see Appendix D for the full survey results). One of the 46 had more than 1 certification (ID24-LEED AP, LEED ID+C, Living Building Challenge Ambassador and Facilitator). Those who stated "yes" to having some training or designation but did not provide or list their credentials could be indicating a desire to have more training, as developing an expertise in green building is often overshadowed by more pressing concerns of managing existing workloads (Hoffman & Henn, 2008).

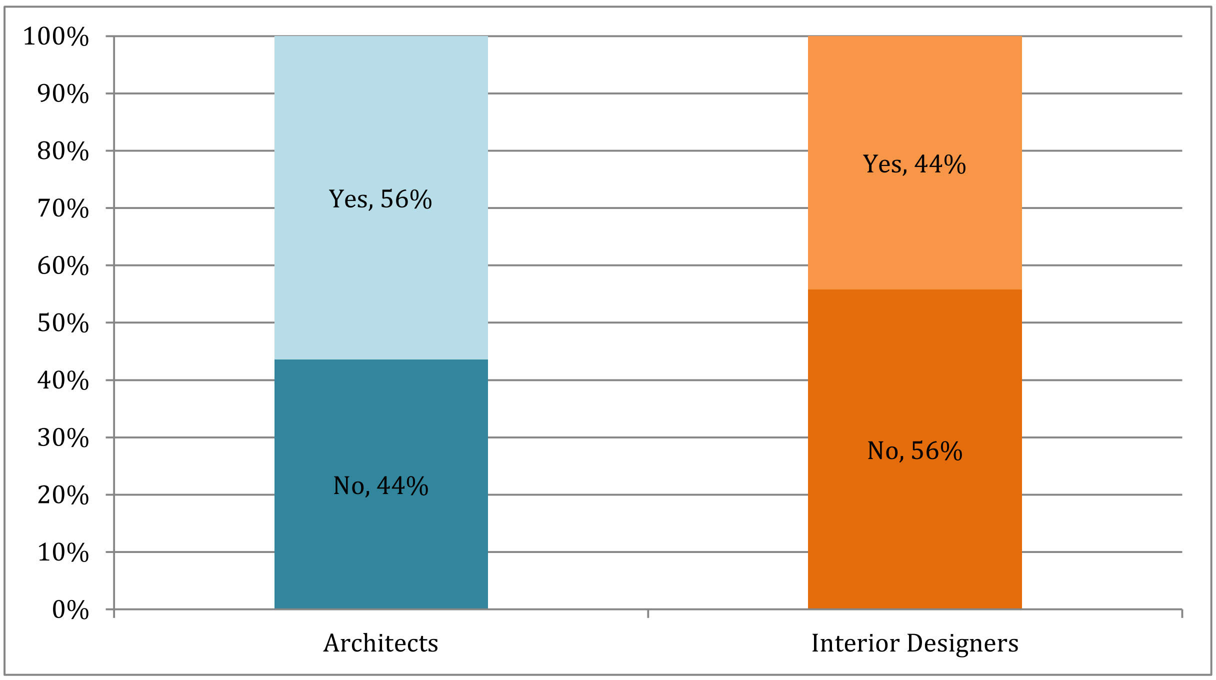

Figure 5.4: Percentage with green training/certifications

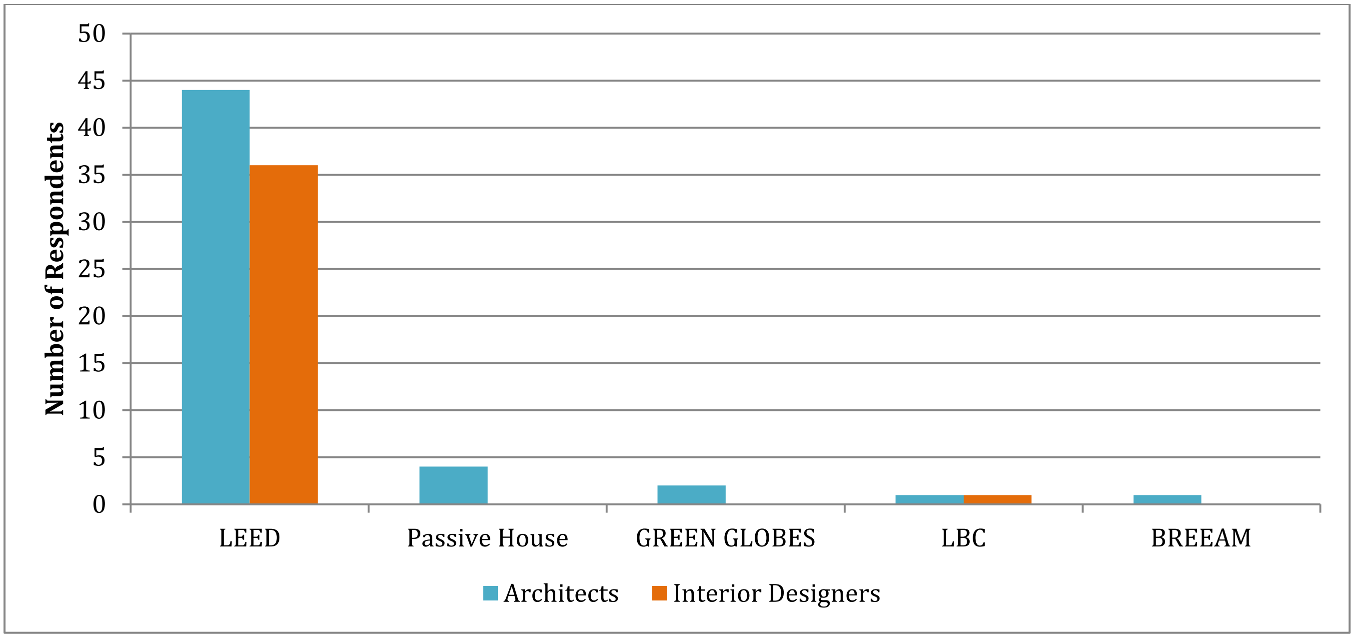

Figure 5.5: Training and/or certification credentials

- **Question 5**: "*Of the total number of projects you worked on in the last two years, what percentage have been certified sustainable or green?*"

With a significant differential, the highest number of both groups of respondents, 39% (n=39) of architects and 60% (n=62) of interior designers responded that none of the projects worked on over the last two years had been certified sustainable or green, as shown in Figure 5.6.

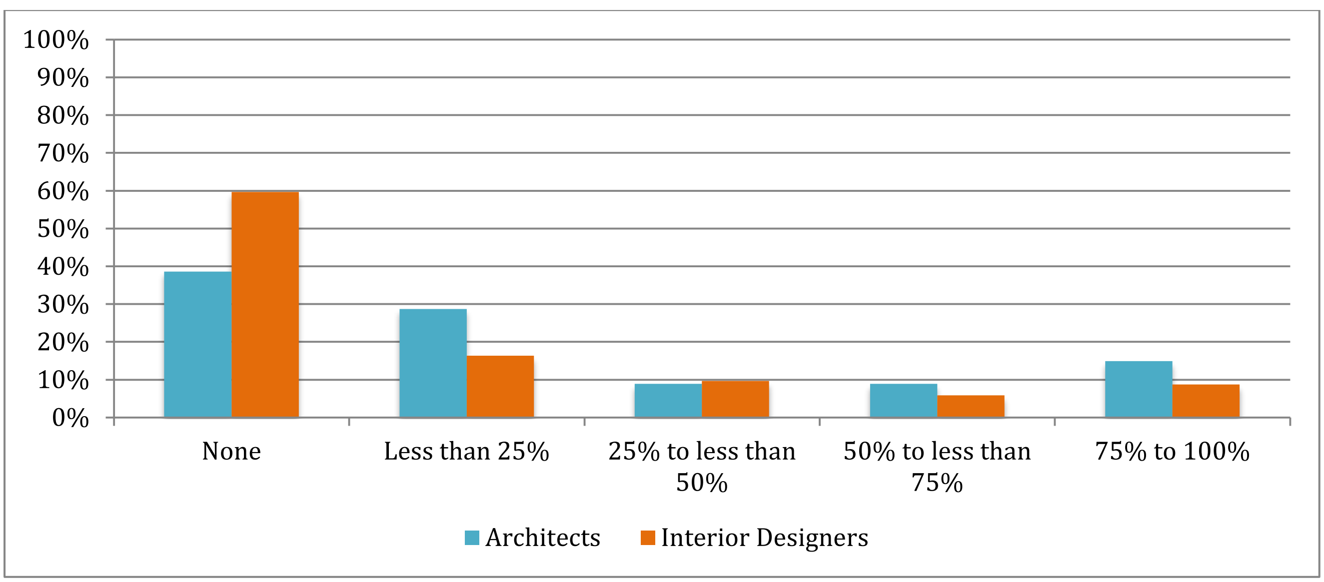

Figure 5.6: Percentage of certified green projects worked on within the last two years

Of the 39% (n=39) architects who responded, “none,” 62% (n=24) have no sustainable design designation, though 28% (n=11) of them are LEED accredited. Five percent (n=2) of the architects in the “none” category have a Passive House designation, a curious insight, demonstrating the lack of concern with interior materials in the Passive House standard. Fifteen percent of architects responded “75%-100%,” with 80% (n=12) of them having some green training of certification. While only 3 of them specialize in healthcare, 5 indicated commercial as their expertise and 1, specializes in green design.

Of the 60% (n= 62) of interior designers who responded “none” for projects that were certified green within the last two years, 26% (n=16) are LEED accredited. Nine percent of interior designers responded “75%-100%” of projects were certified green, with 55% (n=5) of those having green training or certification, and 44% (n=4) of them specialize in healthcare, which is relevant and somewhat expected, as the adverse human health impacts of materials are well known, documented, and avoided in healthcare interiors. One of the 4 architects and the single interior designer with multiple green designations fell into the “75%-100%” category as well.

These data show that 69% of the total participants who have not worked on projects that meet any GBRS standards also do not have any green training or education. On the other side, there is a disconnect: 26% (n=7 of 26) who indicated that 75%-100% of all their projects are certified green, have no training or designation in sustainable design. While 50% of all participants are accredited in GBRS, the fact that 40% or architects and 60% of interior designers stated that none of their projects within the past two years were green could indicate more that there are challenges and barriers to certifying complete buildings and projects, than a lack of professional interest in green building, as the number of certified professionals suggests.

- **Question 6**: *“Of the total number of interior materials you specified over the last two years, what percentage were certified environmentally preferable or green?”*

Both architects and designers had the highest response rate within the “25-50%” category, 24% (n=23) and 29% (n=30) respectively, with 57% (n=13) of the architects and 23% (n=7) of the interior designers in this category being LEED accredited. Sixteen percent (n=16) of architects responded “none” to question 6, 19% (n=3) who have LEED accreditation and 1 with Passive House (AR15).The remaining 75% (n=12) have no green training. Three percent of interior designers (n=3) responded that they have specified no green interior materials within the last two years; 67% (n=2) of those have no sustainable designations, and the third (ID34) teaches at a college. Therefore, all three designers who have not specified any green materials also do not have any sustainable design training.

Seventeen percent (n=17) of architects and 20% (n=20) of interior designers responded that 75-100% interior materials specified over the last two years are sustainable. All but 2 of the 16 architects (88%) have a recognized sustainable design certification, 75% (n=12) of which are LEED while 13% (n=2) are Passive House certified. The link between interior designers’ adoption of green materials and sustainable design certification is slightly different than that of architects. Of the 20% who responded “75%-100%,” 45% (n=9) do not have green certification and the remaining 55% (n=11) are LEED accredited.

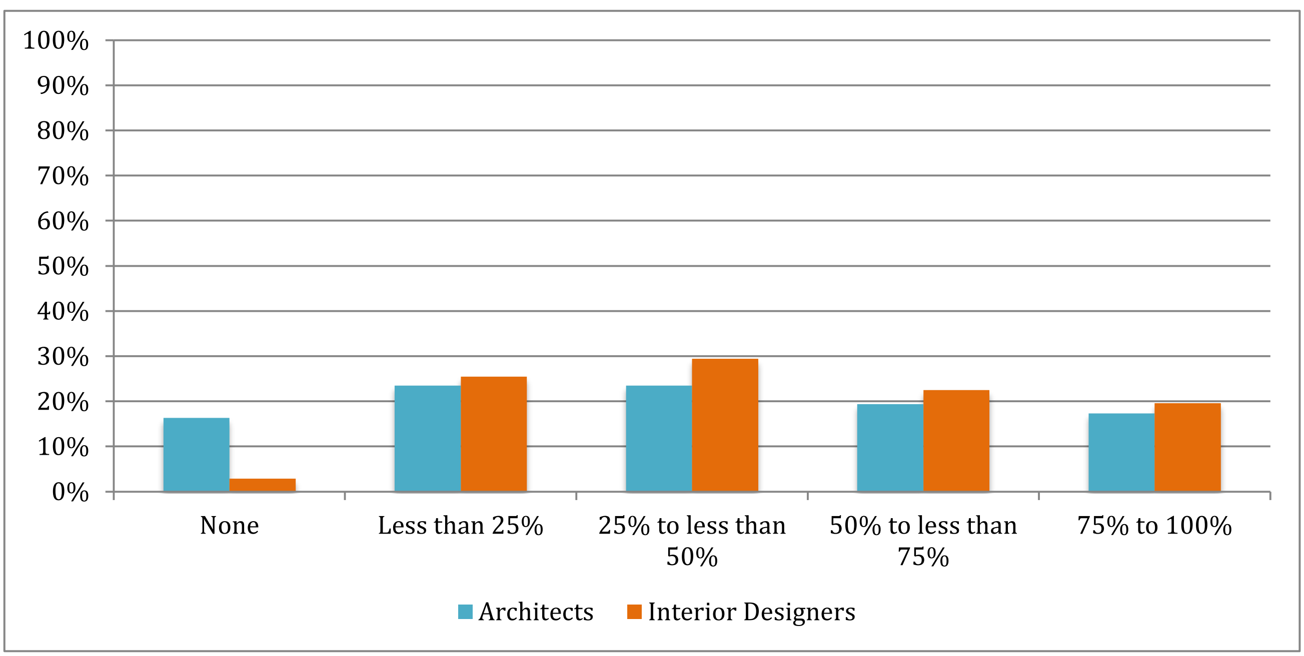

Figure 5.7: Percentage of certified green interior materials specified within the last two years

A positive relationship between Question 5 (projects meeting GBRS certification) and Question 6 (amount of EPP materials specified) would be expected, especially with the Materials and Resource credits in LEED (even more so in LEED v4). However, 50% of interior designers who selected “75%-100%” in Question 6 responded “none” in Question 5, while 25% of architects who responded “75%-100%” in Question 6 responded “none” to Question 5.

The 16 architects and 6 interior designers who answered “none” to this question were directed to the final question as some experience working with sustainable materials were required for the remaining questions. These participants were asked to complete question 28 and identify the largest barrier to the specifications of environmentally preferable interior materials.

- **Question 7**: “*Of your projects over the last two years in which environmentally responsible design (ERD) was/is a significant factor in the decision making process, how often did this ERD mandate come as a project requirement from the client?”*

One of the objectives in this study was to understand the requests from, and influence of, clients in relation to the state of green building and sustainable materials in the built environment. Figure 5.8 below indicates that clients very rarely are the reason for projects to be pursued in a sustainable way.

Both architects and interior designers identified the clients as having very little influence on whether their designs met some environmental criteria. Architects stated that a mandate comes from the client only 18% (n=14) of the time, while interior designers responded that a request comes from a client only 8% (n=8) of the time. The overwhelming response, with 67% (n=52) of architects and 81% (n=76) of interior designers, stating that clients requested the ERD mandate less than 50% of the time, indicating clients are not the reason for projects to pursue environmentally responsible design criteria or certification.

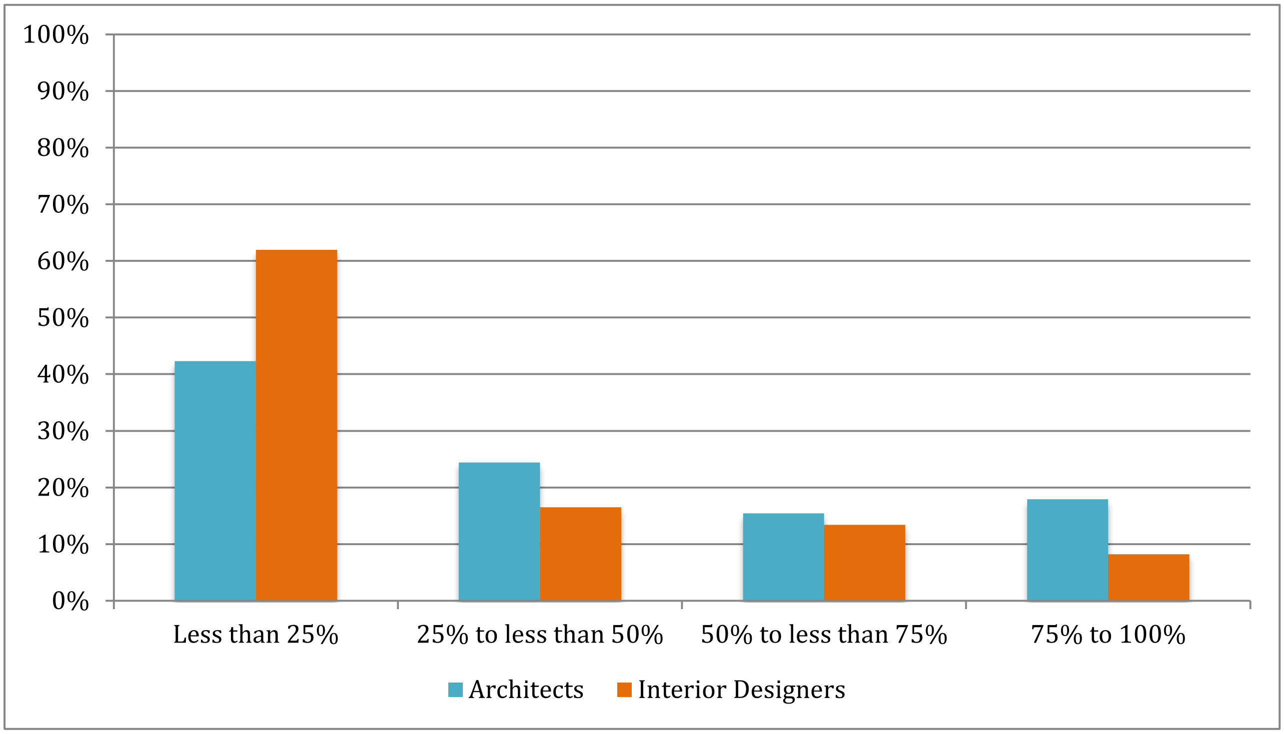

Figure 5.8: Percentage of sustainable design requests from client

The results from this question could be interpreted in two ways. One is that clients are lacking awareness or education on the environmental impacts of the built environment, or they have yet to establish a strong connection between buildings and climate change or recent adverse climate activity. Clients may also not be willing to add sustainable design to their list of project requirements, for fear it may add time and/or cost to their project.

The second interpretation of the response to this question places the lack of client interest and sustainable design requests with the professional. Assuming that most clients will have limited understanding of the environmental impacts of conventional buildings and materials, and the benefits of green buildings and interiors, the professional responsibility lies with architects and interior designers to educate the client, or provide ERD as an option, and then allow them to decide if it becomes a project component.

It is noted that after reviewing the results of Question 7, a "never/sometimes/often/always" question design may have led to clearer result interpretations.

- **Question 8**: *“What is your primary motivator in specifying environmentally preferred interior materials”*

This question aims to discover why architects and interior designers work with sustainable materials if it is not a client request for the project. Responses are illustrated in Figure 5.9.

Architects did not respond to this question with a single clear message: 33% (n=26) indicated, “Personal values” while 34% (n=27) stated “mission of the firm” (34%) as the primary motivator to selecting and specifying sustainable interior materials. The overwhelming motivation for interior designers to specify green interior materials, however, was “personal values,” with 57% (n=55) of responses. The second most stated motivation was “mission of the firm,” with 21% (n=20) of interior designers indicating this as the reason behind selecting green materials.

The most interesting result in this question is that only 13% (n=10) of architects and 9% (n=9) of interior designers who select and specify environmentally preferable interior materials do so in order to meet project certification (i.e., LEED). Given that almost 50% of survey participants are LEED accredited, it could have been expected that more projects, and therefore more materials, were selected in order to gain credits for GBRS certification. Responses to this question are in agreement with the number of green projects architects and interior designers have worked on.

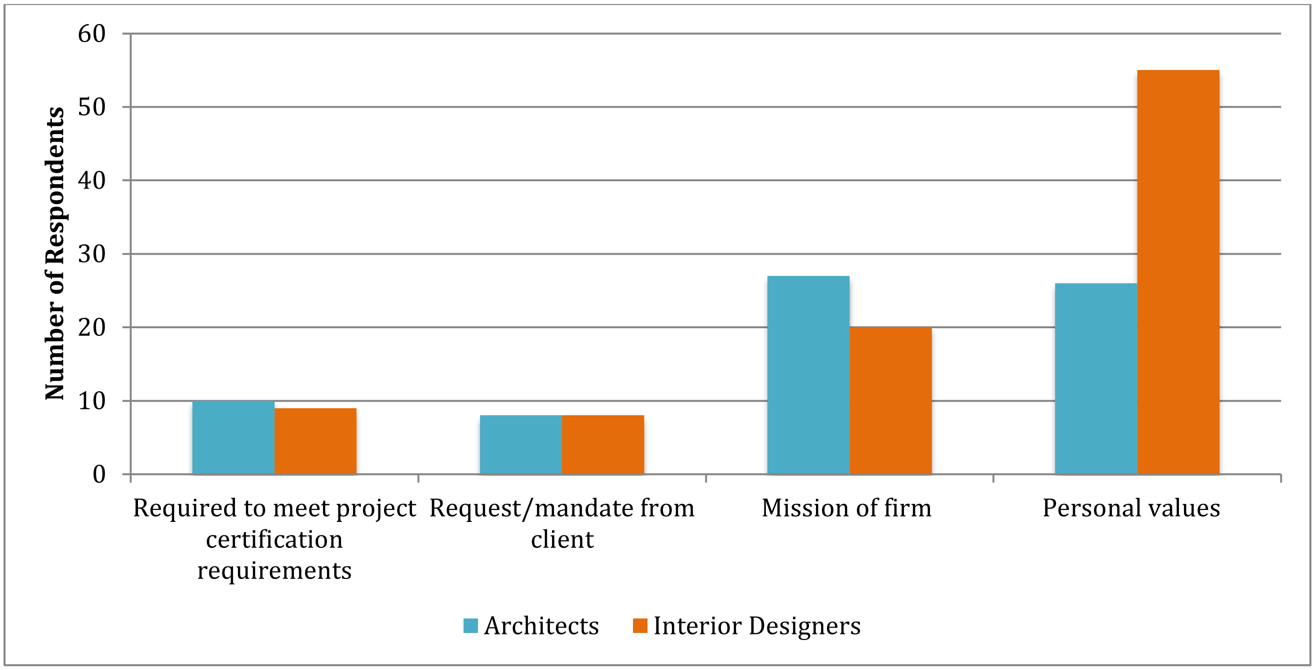

Figure 5.9: Motivation for specifying green interior materials

- **Question 9**: *"When specifying environmentally preferred materials, what resources do you use to make decisions?"*

The field of green building is flooded with eco-labels, product certifications, and sustainable material databases (see Appendices A1). However, the responses to Question 9 (illustrated in Figure5.10) identify a huge gap in both knowledge and utilization of available tools by architects and interior designers who select environmentally preferred interior materials. The results to this question also question the validity in the transparency movement currently gaining momentum, discussed further in the following paragraph.

The most common resource used to assist in selecting environmentally preferable interior materials, by both architects and interior designers, is "manufacturer's literature" (whether accessed via online or in print format). With 63% (n=50) of architects and 65% (n=63) of interior designers indicating that the product literature provided by a manufacturer is the resource most often relied upon for a product's environmental attributes, this category had a remarkable lead over the second most used resource, "materials library" (architects at 19%, and interior designers with 27%). As identified in the Literature Review, there is an inherent dichotomy in transparency when looking to a manufacturer only for a material's environmental qualities, as a manufacturer's primary goal is to sell product (Kang et al. 2009, Cargo 2013). Such a large percentage of architects and interior designers indicating "manufacturer's literature" as their resource for selecting environmentally preferable materials suggest third-party certification is not required.

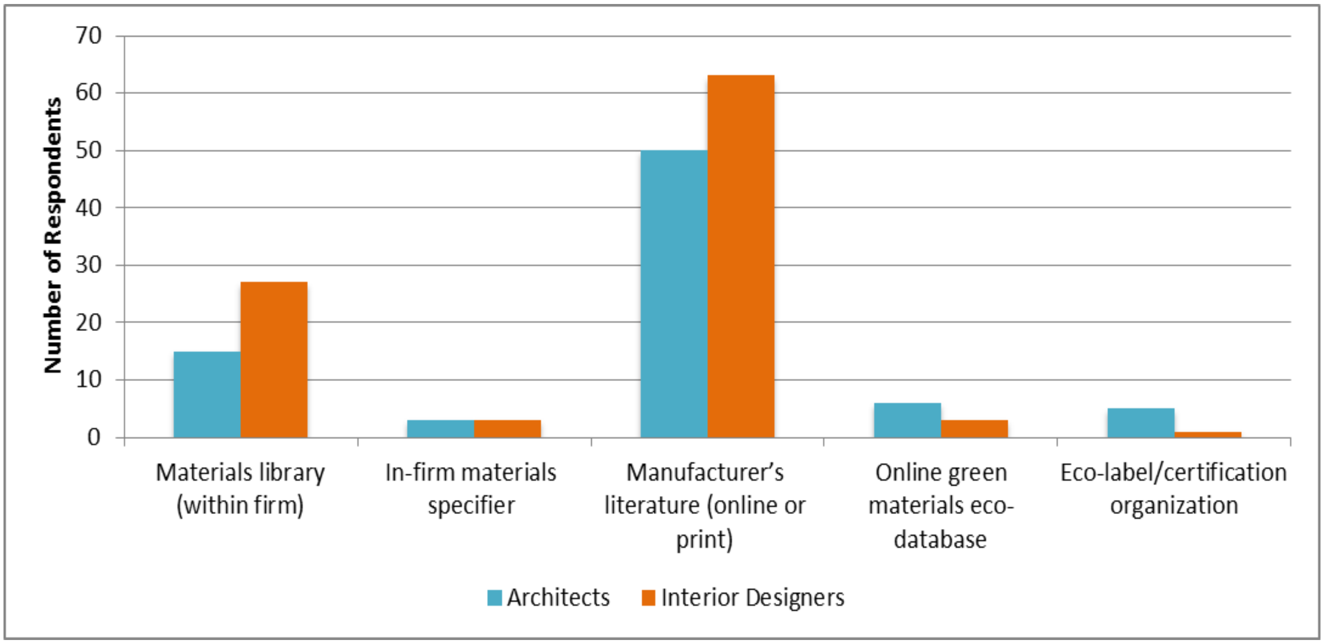

Figure 5.10: Resources utilized when specifying green interior materials

Of most importance to this study was the low reliance upon material databases (i.e., The Pharos Project, Transparency, Declare) and material ecolabel/green material certification websites (C2C, ECOLOGO, GREENGUARD, etc.). Only 8% of architects (n=6), and 3% interior designers (n=3) used an eco-database to search for and/or research EPPs, whereas 6% of architects (n=5) and 1 designer (1%) used the eco-label websites to as a resource to specify green materials. Those that selected either of these options were asked to list all of the databases/ecolabels websites that they use, and they are listed below:

Table 5.2: Architects' responses to eco-databases and ecolabels sites used

Online green materials eco-database:	Eco-label/certification organization:
• *"Follow recommendations in Living Building Challenge – Red List* • *"GIGA MATTER DATABASE"*	• *"LEED, LBC, BREEAM"* • *"Cradle to cradle or green guard"* • *"EPDs, Sustainable Forestry*

• *"Building Green"* • *"Green Building News"*	*Initiative, EcoLogo, Indoor Advantage Gold, Green Seal, GREENGUARD, FloorScore, CSA, Forestry Stewardship, Green Label®, Council, American Tree Farm System"* • *"The Architects Reference Library (Phoenix)"*

All 6 of the architects who used databases for specifying green materials were LEED accredited, with 4 of them stating "personal values" and the remaining 2 listing "mission of the firm" as the primary motivator for ERD. The fact that 100% of the database users were LEED accredited is notable, however only 4 listed the sites used (Ar9, AR17, AR20, AR51), and only 1 of those listed a site that directly relates to a GBRS: the Red List used in LBC. Although there is a correlation between LEED professionals and online eco-databases use, there is not a direct link between LEED training and using eco-databases that offer LEED credit option, suggesting that even with the availability of LEED points, resources are not used. Three of the 5 architects (60%) who use ecolabel certification/organization websites have green training designations, and 4 of the 5 (80%) stated "personal values" as their primary motivation, with the remaining 1 responding "required to meet project certification requirements".

The 3 interior designers who used an eco- database all specified "personal values" as their primary motivation for selecting EPPs, yet none of them had any green training or designations. The single interior designer who used an eco-label website (listing "*Greengard, cradle to cradle, LEED credit contributing material")*also did not have any sustainable design training, but did indicate their motivation for specifying green materials was a "request or mandate from the client."

Table 5.3: Interior designers' responses to eco-databases and ecolabels sites used

Online green materials eco-database	Eco-label/certification organization:
• *"Cradle 2 Cradle, Good Guide"*	• *"Greengard, cradle to cradle, LEED credit contributing material"*

There a few important interpretations from the results of this survey question. First, results show that there is significant underutilization of two large resources available to architects and interior designers. The databases storing hundreds of thousands of sustainable materials and their ingredients (including, though not limited to, The Pharos Project, Transparency, and Declare) should be much more widely used by professional specifying green materials. Of the 176 architects and interior designers who responded to the question, only 5% (n=9) used an eco-database as a resource. Even fewer participants (3%, n=6) utilized the website of an interior material ecolabel organization or certification system (e.g., C2C, FSC, ECOLOGO, GREENGUARD, etc.). Although current GBRS offer points to products with these certifications, surprisingly few of the available resources are used to select environmentally preferable materials. A second observation is related to the reliance on the manufacturers own literature to select green materials. Although the transparency movement is gaining traction (and not just in ingredient disclosure, but also in manufacturing processes, location of material origin, social fairness of workers, etc.), there is an inherent lack of trust in information provided by a manufacturer whose goal is to produce and sell as much product as possible, and will be suspected of greenwashing. These data illustrate the need for more exposure and/or education of the resources available to assist in selecting environmentally preferable interior materials.

- **Question 10**: *"What label and/or supporting documentation is the most important to you when specifying an environmentally preferable material:"*

Question 10 explored how architects and interior designers specify environmentally preferable products, based on the label or documentation supporting environmental claims. Participants were asked to select one answer, with "other: please list" the final option.

As Figure 5.11 indicates, the "material ingredients" is rated the most important documentation by both architects (24%) and interior designers (30%) when selecting an environmentally preferable interior material. Slightly behind was "green building rating system credit potential" for architects (23%), and "EPD" for interior designers (also 23%). Of the 23% (n=16) of architects who stated the green building rating system credit potential was the most relevant when selecting a material, only 13% (n=3) were not LEED accredited professionals.

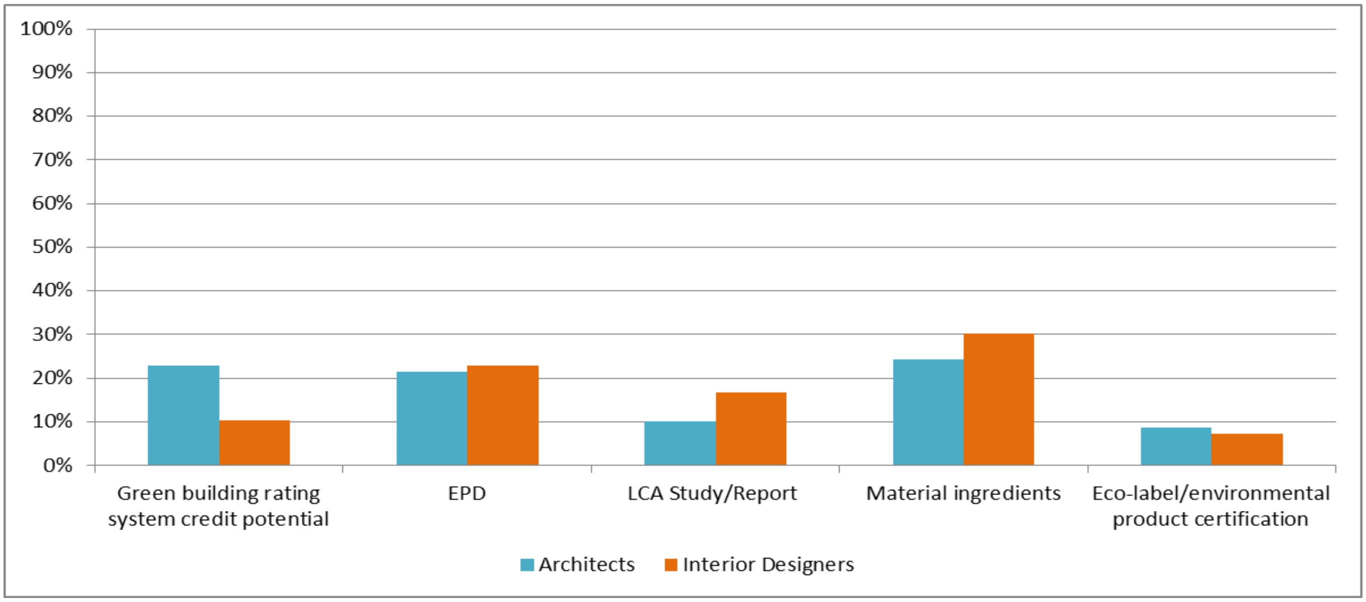

Figure 5.11: Label or documentation sourced for green material

The results of this question will be discussed and analyzed in further detail, and used for comparison with Questions 16, 18, 20, 22, 24, 25, and 27.

- **Question 11**: "*Which eco-label(s) or environmental product certification(s) do you most often include in interior material product specifications*"

The goal of Question 11 was to identify the most commonly sourced eco-label or certification used by architects and interior designers, and to relate the findings back to the current state of green building materials and ecolabels. Participants were asked to list the certification or ecolabel most often used. Figure 13 shows the results to this question.

Figure 5.12 below identifies the Forest Stewardship Council (FSC) label as the most often included product specifications written by 27% (n=13) of architects and 12% (n=13) interior designers. Given that products with FSC rating earn credits within the LEED MR category, and this rating covers all wood products from structural materials to interior finishes, it is not surprising that FSC was the label most often specified. Architects and interior designers both included LEED as the third most specified label or product certification. This is curious, as LEED does not certify products, nor do they endorse individual manufacturers, "LEED certification applies only to buildings and neighborhoods. Although USGBC does not certify, promote, or endorse products and services of individual companies." (USGBC 2016d). Eight percent (n=5) interior designers listed the CaGBC as the label or certification most often included, although the CaGBC also does not endorse products. Four of the 5 (80%) architects and 4 of the 7 (7%) of interior designers in this category are LEED accredited professionals, a response which generates more questions than answers: are LEED professionals, especially architects, focused primarily on the building and not the interior, and so do not understand the MR credits? Is there so much confusion surrounding sustainable materials, materials in LEED and product labels that some think there are LEED certified products? Or, might the respondents have included LEED intending for it to mean labels like FSC or C2C that earn LEED credits?

After FSC and LEED, there is more of a contrast between the responses from architects and interior designers. The GreenGuard and FloorScore programs (included by 4 and 2 architects, 8 and 1 interior designers, respectively) were both included, yet architects included EPDs (1) and Declare (1) and 3 interior designers include C2C. Two of the four architects who responded GreenGuard were LEED trained, and 2 of the 8 interior designers are also LEED accredited. It is interesting that of the 3 interior designers who included 'C2C' as their response, none of them are trained or accredited with LEED, a system that grants credits to C2C certified materials. Both architects who included 'EPD' as the label or certification included most often in material specifications are LEED accredited, as is the architect who included the Declare list.

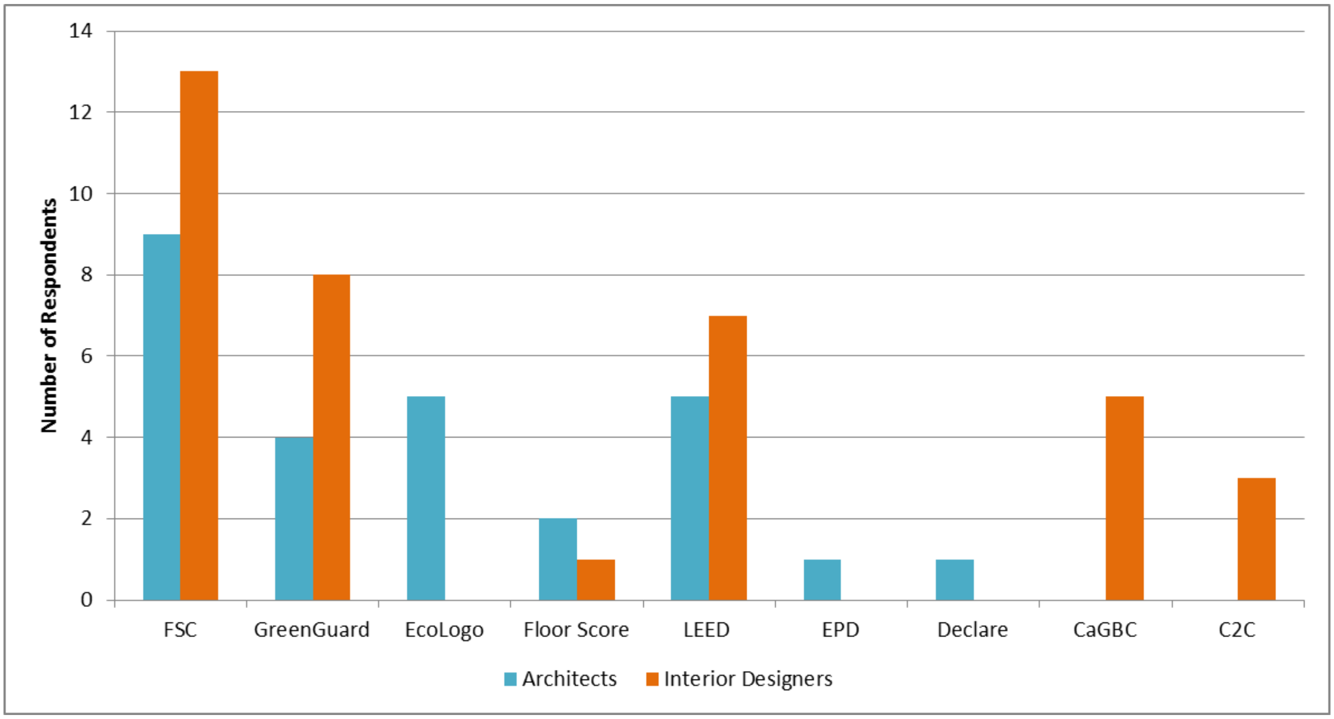

Figure 5.12: Eco-label/environmental product certification adoption

There are 4 insights provided by these results. FSC continues to be the most recognized and most often included label used by both architects and interior designers, followed by GreenGuard and FloorScore. There appears to be a lack of clarity with materials and ecolabels related to LEED, as LEED offers no product certification. Very few architects and interior designers are specifying products with C2C certification, despite C2C being a large part of both LEED and the material transparency movement. Finally, and supported by the results of Question 10, only a very small percentage of architects and interior designers in Ontario use EPDs or the Declare database, despite their inclusion in GBRS.

- **Question 12**: "*Why is the aforementioned eco-label(s) or environmental product certification system(s) the most often utilized when specifying environmentally preferred interior materials (please rank the three most relevant from 1 to 3, with 1 being most relevant):*"

Question 12 was designed as an attempt to dig deeper into the motivators to the answers of Question 11, using some of them most common environmental values used in assessing environmental impacts from the built environment. The monochromatic charts

(Figure 5.13 and Figure 5.14) identify the three ranks for each of the six values for architects and interior designers, whereas the multi-coloured chart (Figure 5.15) identifies the overall top ranking, or most relevant selection, for both architects and interior designers.

With significance, 50% (n=18) of architects and 53% (n=25) of interior designers rated 'performance/durability' as the number one reason why the ecolabel/certification system identified in Question 11 was used most often. The performance and durability of a product is critically important to decreasing the environmental footprint of an interior (in preventing a low-performance with a short lifecycle from landfill, thus requiring new material) and so the fact that this was the most important factor to selecting a material bodes well for the industry. However, as identified in Chapter II, the performance and durability of materials is not included in most ecolabling programs, only through a lifecycle approach. So, although the performance of a material is selected as the largest motivator to using an ecolabel or certified product, the utilization of LCA reports for architects and interior designers is low (10% and 17%, respectively). Based on the disconnect from most ecolabels covering performance, and yet the respondents indicating this as highly influential, there appears to be lack of clarity and confusion with the ecolabels.

While the order of the second and third reasons flipped from architects to interior designers, 'marketing or visibility of product/manufacturer' (second rank by architects, third by interior designers) and 'required for project mandate' (second rank by interior designers, third for architects). Both of these second and third positions are important to this study, as it validates the influence of manufacturers on architects and interior designers, based on environmental claims made by manufactures (and likely some influence now from manufacturers claiming environmental preference due to a material having an EPD), but also should raise a red flag: without third party verification, manufacturers and suppliers could, and can, make false, or manipulative and unclear environmental claims. And as time to research new products, materials, ingredients and manufacturers has already been identified as a major barrier to greater sustainable design implementation, architects and interior designers may not have the resources to determine if said marketing of a material is valid or not, thus leading to the specification of less, not more, EPPs.

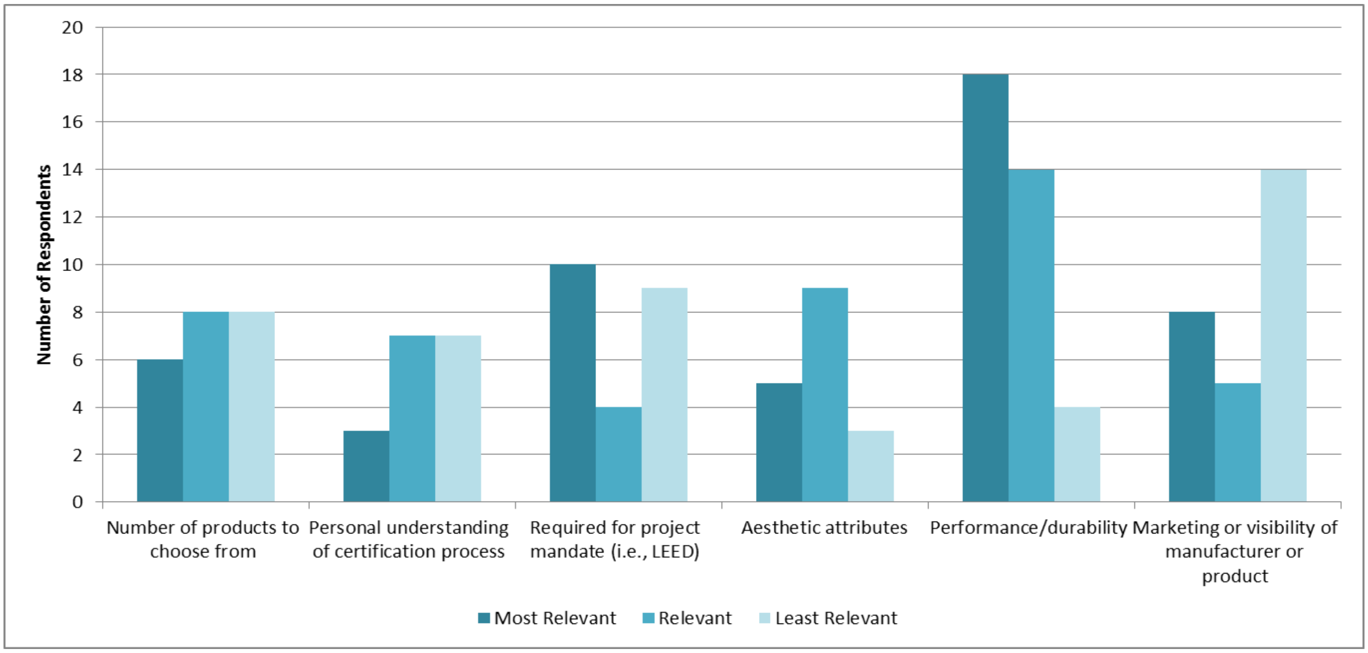

Figure 5.13: Architects top 3 ranking for use of ecolabel/certification system

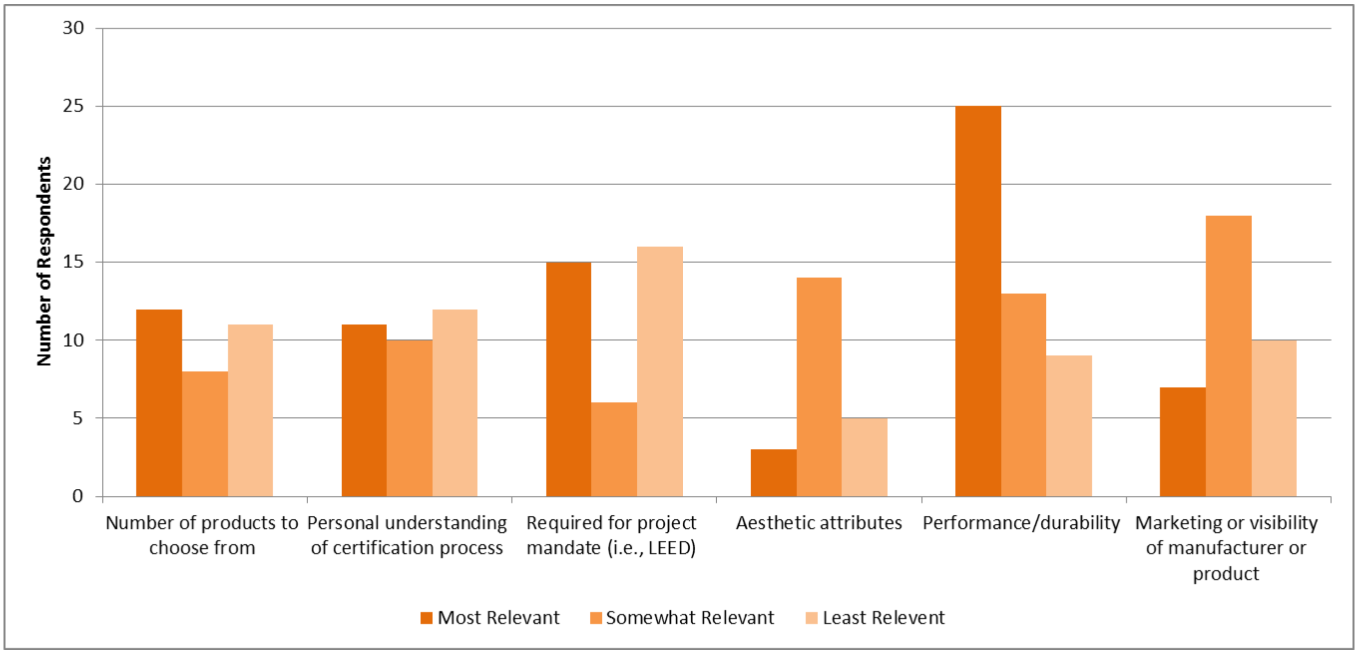

Figure 5.14: Interior designers top 3 ranking for use of ecolabel/certification system

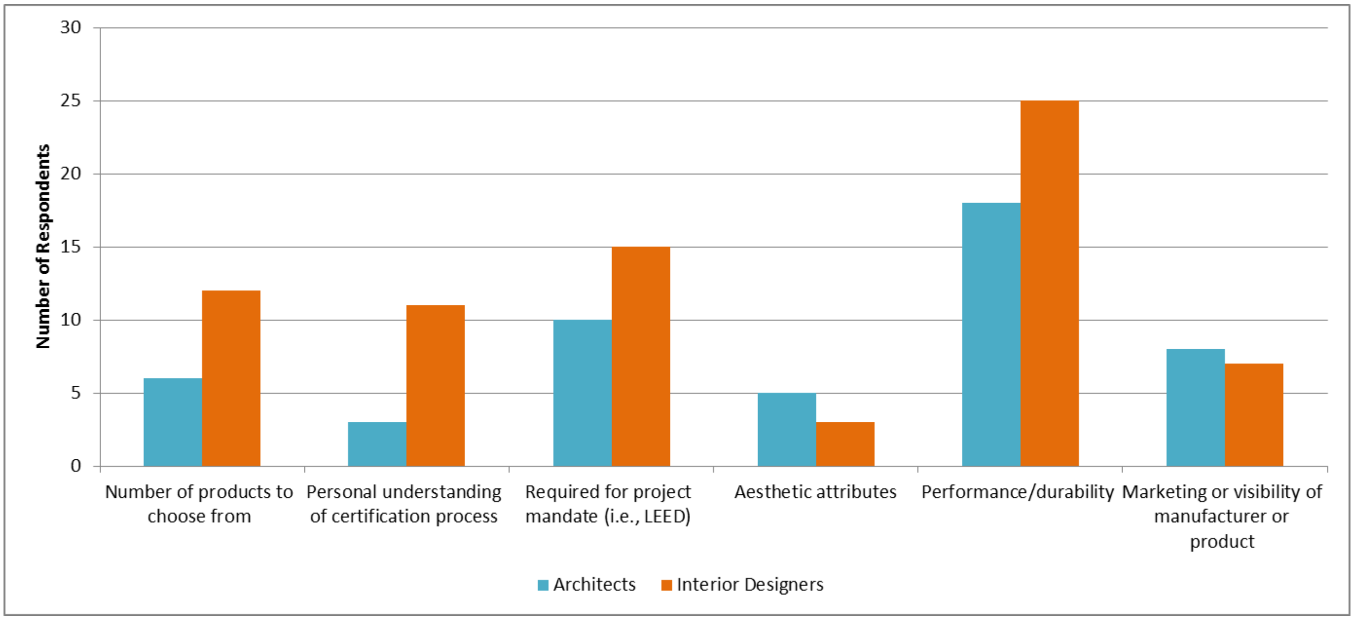

Figure 5.15: Most relevant (number 1 ranking) motivator for use of ecolabel/certification system

The biggest outcome from the responses to Question 12 is signaling an overall disconnect between the ecolabels and product certification systems architects use and an actual understanding of the metrics, criteria and process of said labels and systems.

- **Question 13**: "*When an eco-label or environmental product certification is not available for an interior material, what are the most important factors to you in selecting an environmentally preferred product? Please rank in order from 1 to 7 (with 1 being the most important):*"

Question 13 focuses on understanding the motivators to selecting an environmentally responsible product that doesn't have any certifications or claims. It is important to assess whether the factors of value to architects and interior designers are reflected in existing labels and systems. Figure 5.16 and Figure 5.17 identify the top four most important factors for architects and interior designers (separately), whereas Figure 5.19 identifies the overall most important factor for both architects and interior designers.

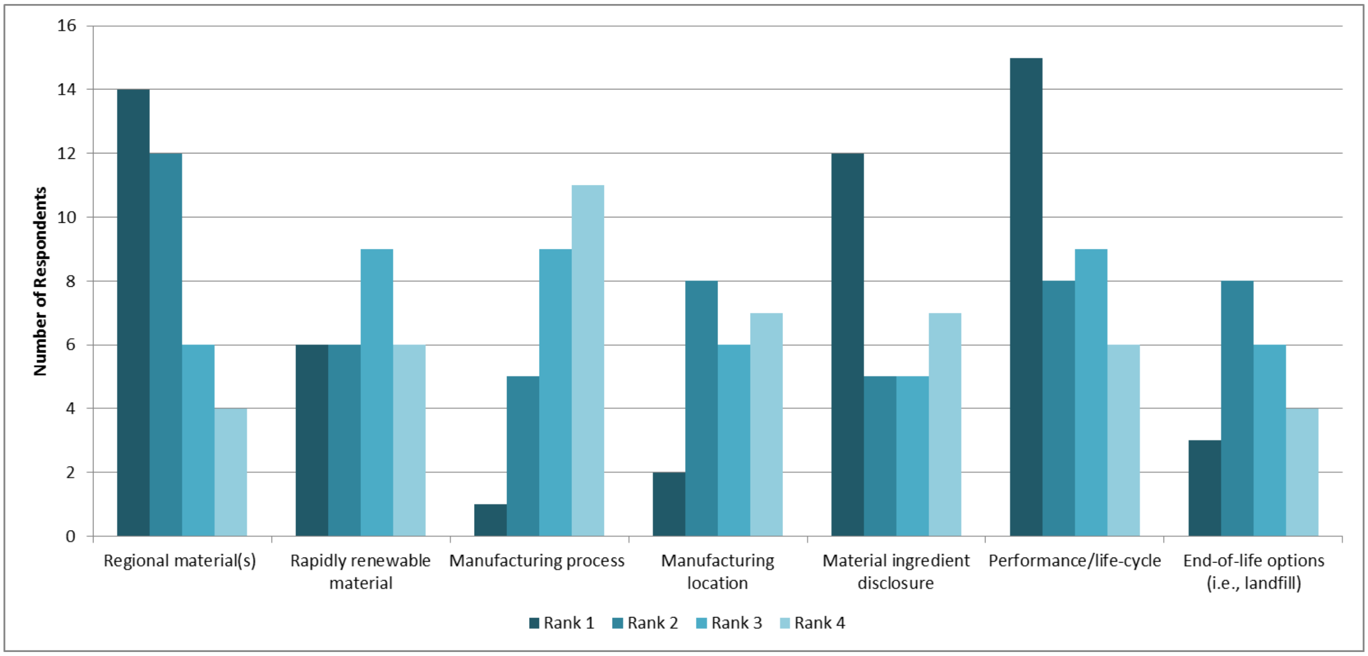

Figure 5.16: Architect's 4 most important environmental factors in selecting an environmentally preferable material without label/certification

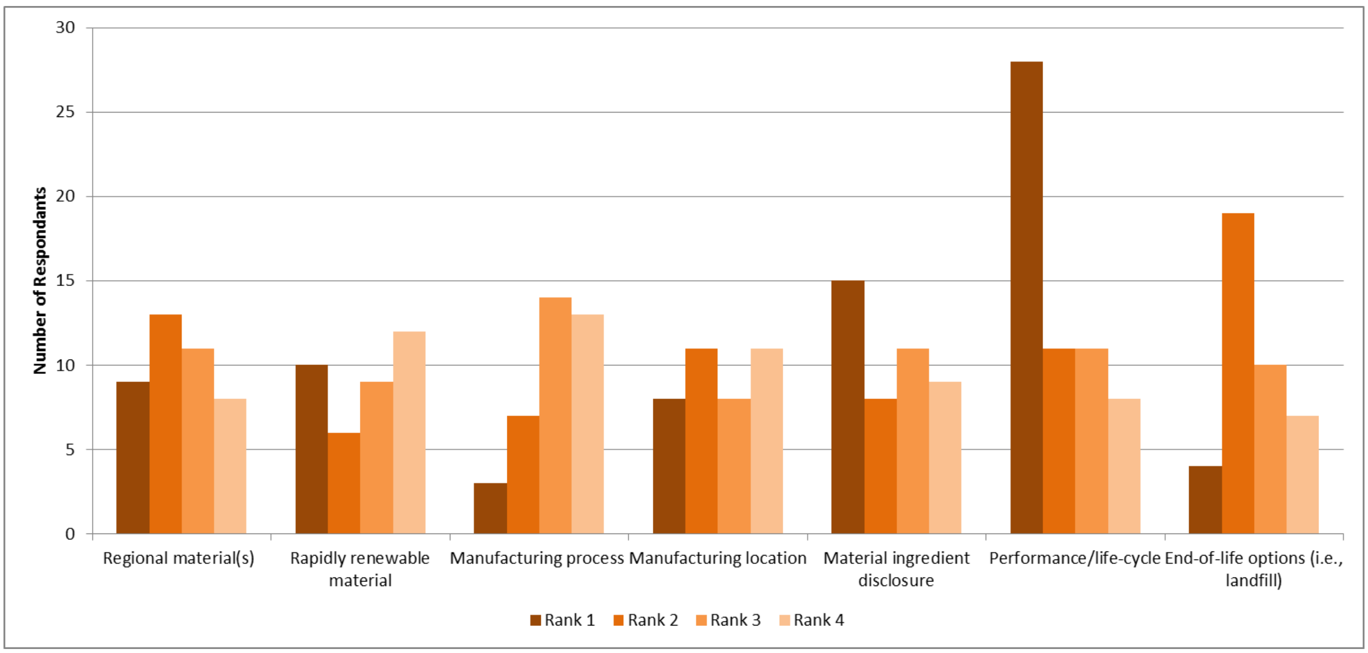

Figure 5.17: Interior designer's 4 most important environmental factors in selecting an environmentally preferable material without label/certification

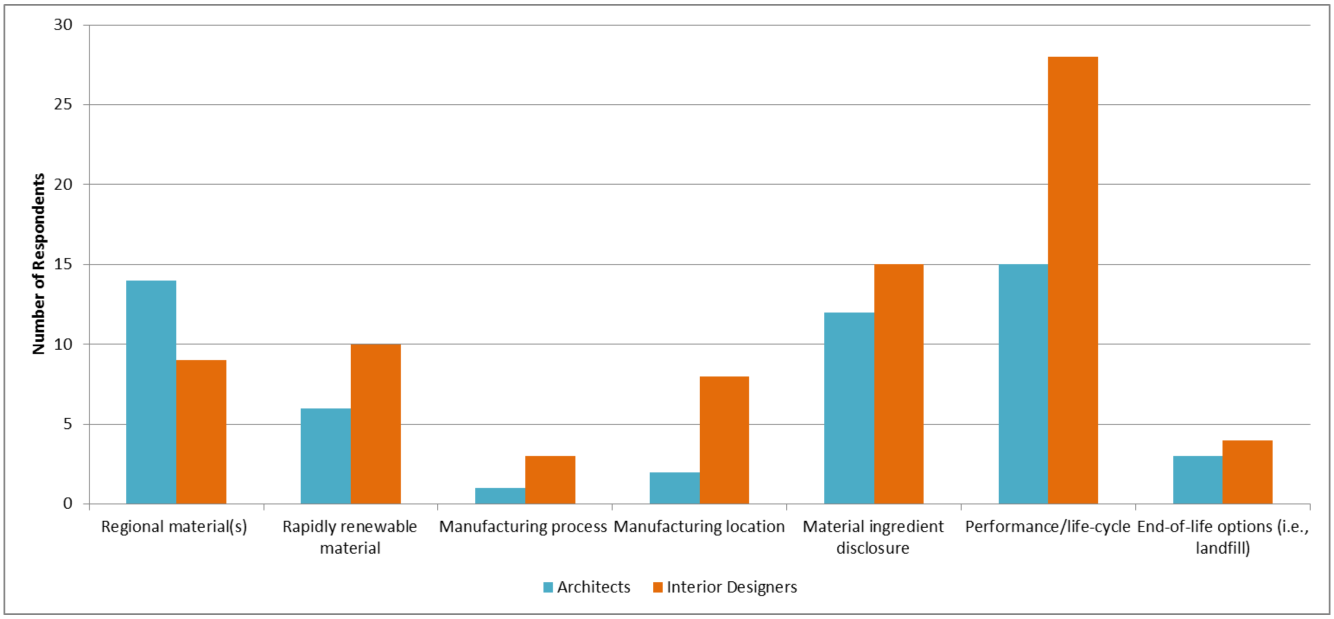

Figure 5.18: Most relevant (number 1 ranking) of most important environmental factor in selecting an environmentally preferable material without label/certification

The responses to Question 13 agree with responses to Question 12: 31% (n=15) of architects and 37% (n=28) of interior designers rank the “performance/lifecycle” of a product as being the most important factor when selecting an environmentally preferable interior material. As discussed in Question 12, many of the product labels used, especially those identified in Question 11 (FSC, ECOLOGO, FloorScore, etc.), rarely captured the performance of a product. 30% of the architects indicated “regional material(s)” as the most important factor, almost tying the first and second most important factors. While regional (or local) materials are of value for projects meeting LEED or LBC requirements, and are addressed in the scope of LCA, regional materials are not valued by product labels or certification systems, even though the location and transportation of raw ingredients or materials can weigh heavily on a material’s overall impact.

‘Material ingredient disclosure’ was ranked as the second most important factor by interior designers (28%) and third (26%) by architects. Comparison of these responses with responses to Question 11 (asking participants to identify the most often used ecolabel or certification system) reveals a clear disconnect.: although 26% (n=12) of architects and 23% (n=15) of interior designers rated “material ingredient disclosure” as most important, and 24% of architects 30% of interior designers responded to question 10 with ‘material ingredients’ as the most important when specifying an EPP, only two architects and three interior designers work with labels or certifications that include material ingredients or exposure (those being EPDs, C2C and Declare). There may be different psychological ways to interpret the reason as to why many architects and interior designers state that material ingredient disclosure is important, yet nearly all of them do not use resources or labels which include disclosure, it identifies a large opportunity for stronger exposure and education into these processes and tools. Question 13 responses agree with the findings from Question 10 (which label or documentation is most important) in that although material ingredient disclosure is considered highly important to both groups, they do not generally use tools and/or label systems that identify ingredients of materials.

The importance of performance and lifecycle are not adequately addressed in current ecolabels, based on the value architects and interior designers place on them. However, a similar conclusion as to the one above indicates that even those the labeling systems, material databases or certification organizations which may touch upon performance and lifecycle (C2C, LCA, and EPPs) are not used for specifying products which meet their performance criteria.

- **Question 14**: *“In your professional opinion, please rank the importance of the environmental factors below when selecting materials (please rank in order from 1 to 7; with 1 being the most important, and 7 being the least):”*

While the previous questions focused on motivators and values of sustainable materials related to current ecolabels and certification systems, the objective of Question 14 was to understand the personal value hierarchy of architects and interior designers when selecting materials, and use these data to compare to Questions 13 and 15. These results will provide insight into the relationship between the existing decision-making tools compared with the environmental values of the professionals. Figure 5.19 and Figure 5.20 identify the top four most important factors for architects and interior designers (for the full responses, please see Table D1 in Appendix D), Figure 5.21 identifies the single most important factor selected by architects and interior designers.

Indoor air quality/toxicity was rated the most important environmental factor for both architects (43%) and interior designers (42%), with a marked lead over all other factors. Similarly, both groups selected ‘Life-cycle’ as the second most important factor. Although it was expected that, due to overlapping scopes of work, education, and experience, their responses to this question would be somewhat similar (especially as it specifically asked for their “professional” opinion), it is remarkable how aligned the responses are. The heavy influence of indoor air quality on material selection for architects and interior designers suggests that ecolabels focusing on VOCs and off-gassing (e.g., FloorScore) are more valued than those focusing on factors perceived as less important (i.e., regional materials or embodied energy). These data help explain why the FloorScore label was listed as an ecolabel most often used by architects and interior designers in Question 11. And while indoor air quality is emphasized within LEED, it is primarily though the Indoor Environmental Quality (IEQ) category, not the Material & Resource credits (MRc). The factors that are addressed in LEED MRc are those that had the least overall importance ranking: regional material and rapidly renewable. Only four architects and no interior designers ranked ‘embodied energy’ as the most important factor, signifying labels or systems with a focus on embodied energy are nearly redundant.

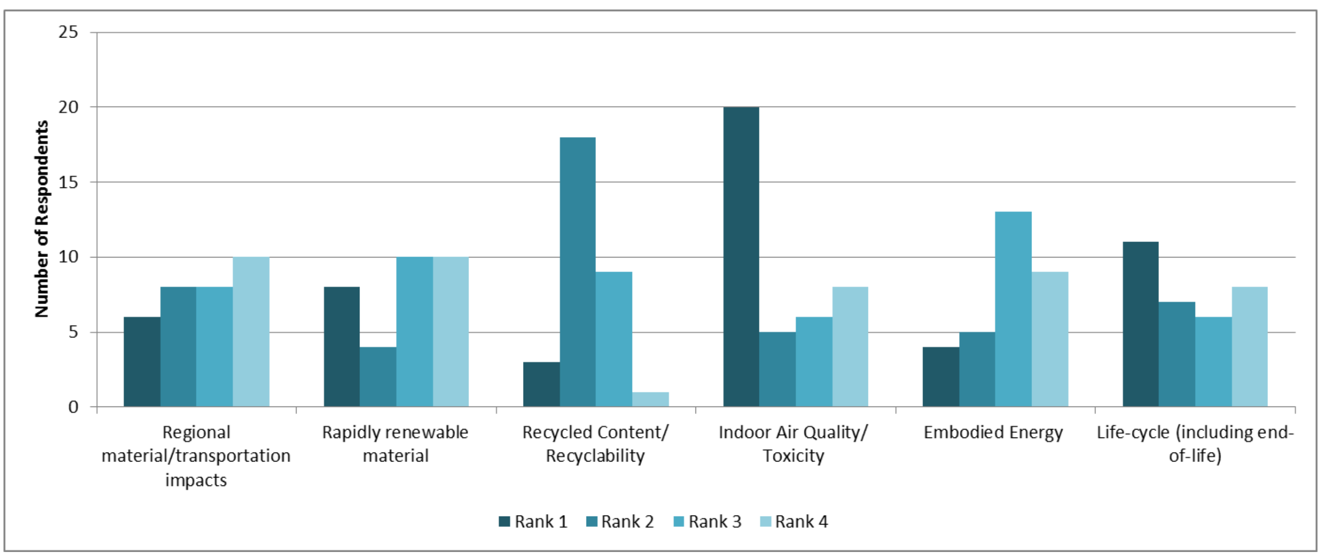

Figure 5.19: Architect’s 4 most important environmental factors in material selection

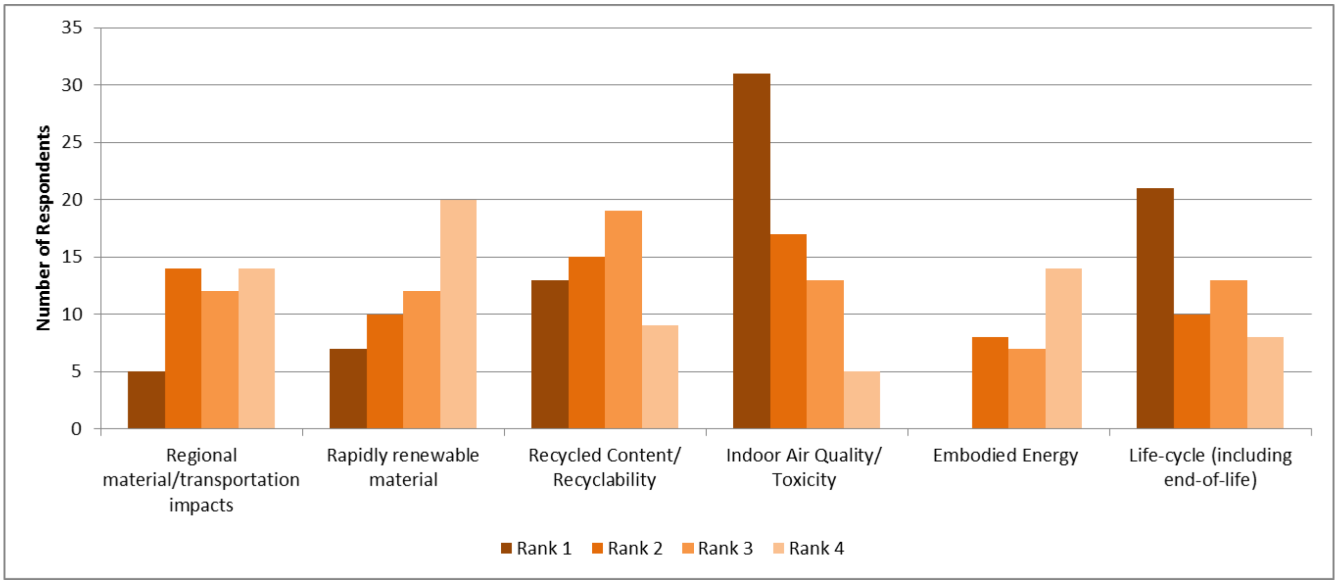

Figure 5.20: Interior designer's 4 most important environmental factors in material selection

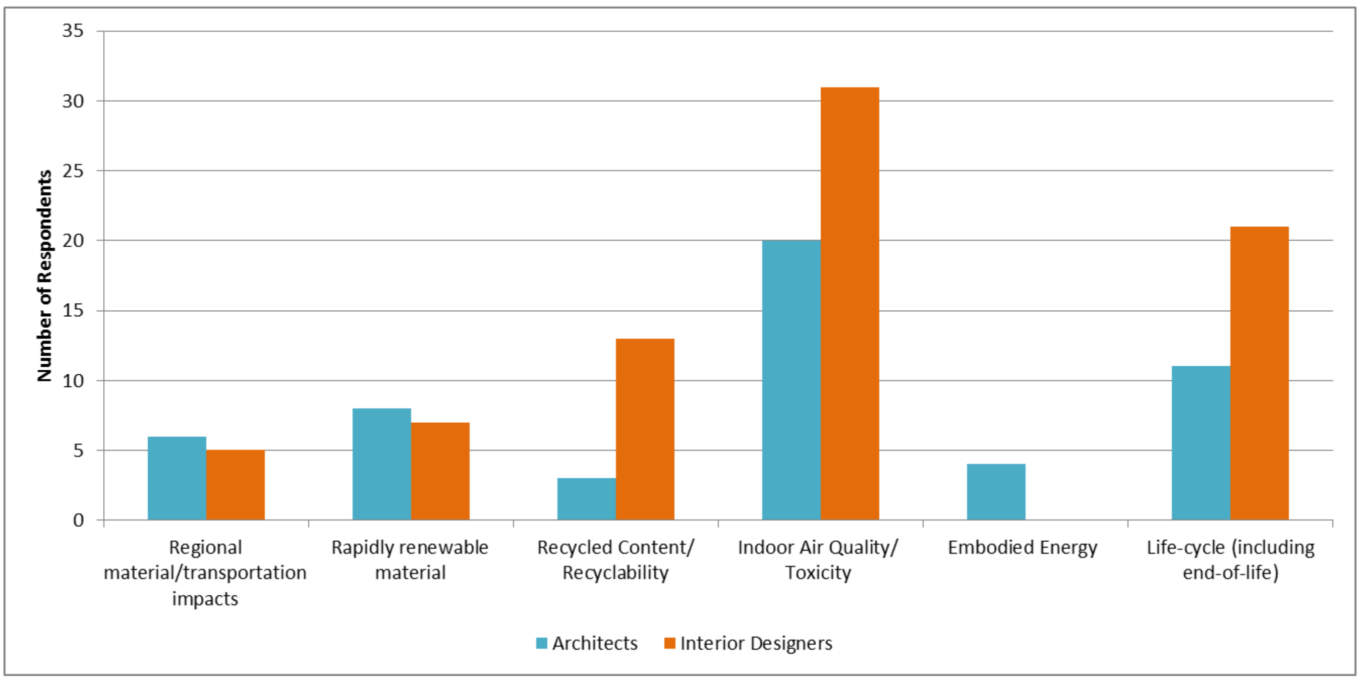

Figure 5.21: Most important environmental factors (number one ranking in material selection

Several common "other" factors were listed by architects and interior designers as important environmental factors not included in the provided list are collected in Table 5.4 (for the full list, see Table D1 in Appendix D). Cost was identified by both groups (mentioned in the Literature Review as the biggest perceived barrier). Durability and reusability of the material were mentioned by three architects, which relates to the high response of ‘performance/durability’ in Questions 12 & 13, while demolition was listed by two interior designers, reflecting the concept of churning within the industry.

Table 5.4: Common “other” environmental factors

Barrier	Architects (n= value)	Interior Designers (n= value)
Durability	n=3	n=2
Cost	n=1	n=1

- **Question 15**: *“When a client requests environmentally preferred materials, how do they rank the environmental factors below (please rank in order from 1 to 7, with 1 being the most important and 7 being the least):”*

While sustainable design and green building are commonplace topics for most practicing in the built environment industry, they are not yet common within the general population (as evidenced by the responses to Questions 7 & 8). The objective of Question 15 was to identify the motivators of clients when requesting environmentally preferable design and materials, and then to compare these to a) the values of architects and interior designers, and b) current ecolabels, certifications and GBRS. Figure 5.22 and Figure 5.33 identify the top four most important factors for architects and interior designers (for the full results, please see Appendix D), Figure5.24 illustrates the single most important environmental factor from clients for both architects and interior designers.

The results from Question 15 show that the most important environmental factor to a client, for both architects (28%) and interior designers (45%), is indoor air quality. Life-cycle (25%) and recycled content (20%) were the second and third most important factors for architects’ clients, respectively. Recycled content/recyclability was second most important for clients of interior designers (29%), with life-cycle coming in at third (17%). The results, again, are very similar between architects and interior designers, as in Questions 13 & 14. Of particular note is the similarity between the professional values in environmental factors of architects and interior designers to the values of their clients, with indoor air quality being by far the most important environmental factor. This may be the case because clients have sparse knowledge of the many environmental factors associated with building materials, but they would have a direct health interest in, and possibly knowledge of, air quality impacts. These results also support the findings of Kang et al., (2009b) that revealed that sustainable interior materials were less frequently applied components of environmentally sustainable interior design than was indoor environment quality.

Recycled content/recyclability was reported as a significant factor for both groups, though it was more valuable for the architects. This is a somewhat expected result given that most clients have experience and knowledge in recycling. It is interesting that life-cycle was indicated as highly important for architects' clients (less so for interior designers' clients), given the complexity of LCAs. It may be that these responses are related more to the durability and performance of a product, rather than regulated LCA reporting. Architects were not asked to differentiate between life-cycle of a building compared to life-cycle of interior materials. Similar to responses to Question 14, Question 15 shows that embodied energy is relatively unimportant for clients when requesting environmentally preferable materials, which is relevant as the new mandate for LEED v4 includes embodied energy in Material and Resources credits.

The relationship of these data and the clients' influence in the adoption of ecolabels or GBRS is comparable to the results of Question 14: IAQ factors are requested most by clients compared to those which are based on embodied energy or regional material/transportation impacts.

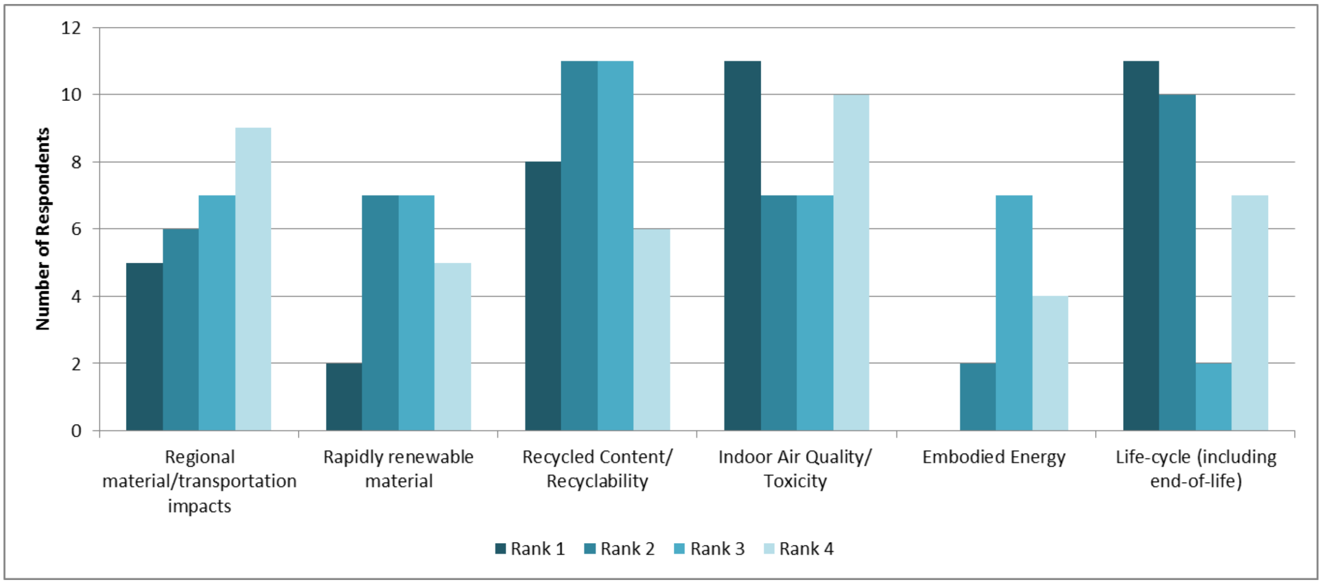

Figure 5.22: Clients of architects' 4 most valued environmental factors

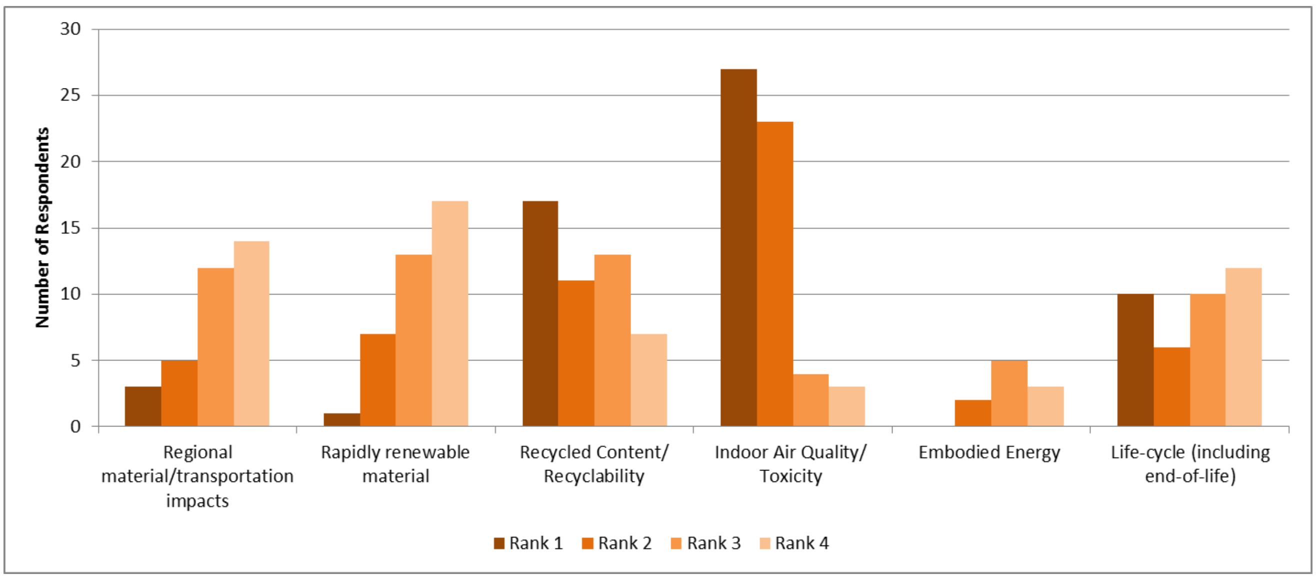

Figure 5.23: Clients of interior designer's 4 most valued environmental factors

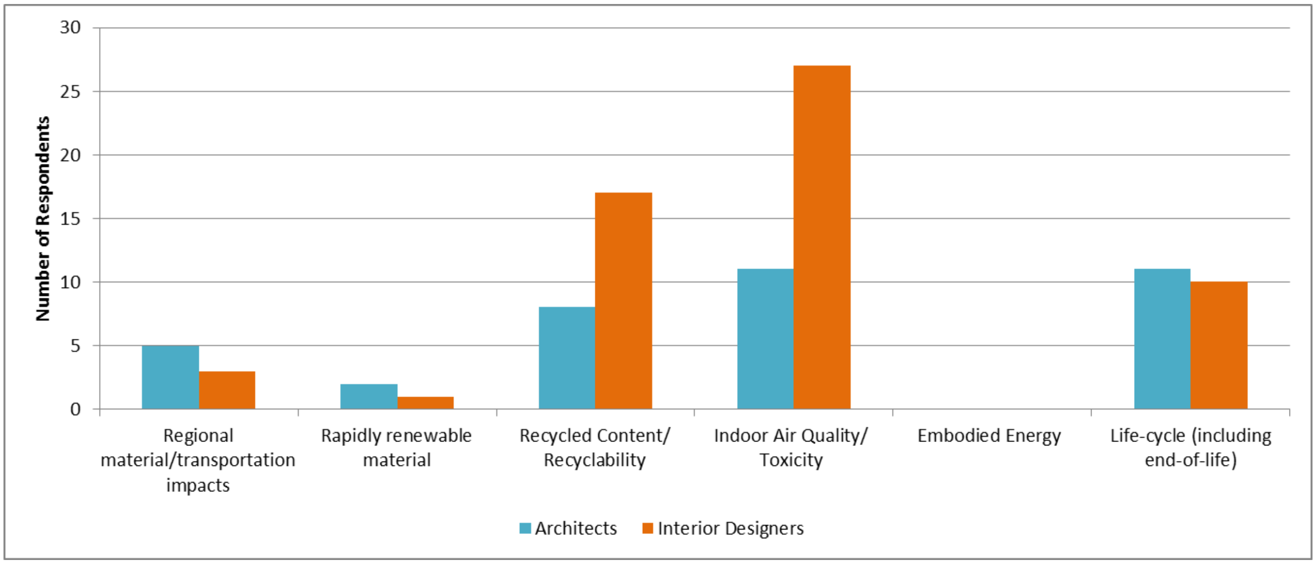

Figure 5.24: Most valued environmental factor, from client

The responses included in the optional “other” selection support the literature identifying cost as the biggest barrier to sustainable design, especially when related to the client. Of the 16 architects who included a response to the “other” category, 11 (or 69%) listed “cost.” The interior designers provided more insight in their responses, so while 3 of the 11 (27%) did list “cost”, 3 others stated that the client doesn’t have much awareness or care. Common other environmental factors used by clients are collected in Table 5.5, with the full list contained in Table D2 in Appendix D.

Table 5.5: Common “other” client environmental factors

Barrier	Architects (n= value)	Interior Designers (n= value)
Cost	n=11	n=2
Client	n=2	n=3

Valuable insight is provided in the responses to Question 15, especially in connection with responses to Questions 7 & 8, which indicate how rarely an environmentally responsible design mandate comes from the client, and how little weight the client carries in motivating sustainable design by professionals. Combined with the results from this question, indicating that there is little ask from clients about environmental issues outside of a clients’ very limited knowledge, there are two opportunities for improvement. The first is to make a connection between IAQ and environmental health (and/or environmental degradation), to increase the value clients place on environmental impacts. The second opportunity is to create more ecolabels and certification systems that are based on the performance or durability of products. This was identified as somewhat important to clients, likely for cost reasons, but identified as the most important environmental factor for architects and interior designers. These proposed labels and certification need to be different than the existing LCA-based systems, based on the fact that the LCA methodology is rarely used by design professionals, as shown in the responses to Questions 10 & 11.

- **Question 16**: *"Please rank the importance of material ingredient disclosure (ingredient transparency) to you when specifying an interior material:"*

As already discussed in this study, the movement toward full ingredient disclosure for materials is already underway, and some are suggesting this transparency movement is going to be the future of sustainable materials. However, many barriers exist, including a lack of disclosure for proprietary material formulas, ingredient disclosure providing a false sense of environmental superiority, and finally, a lack of ingredient understanding among architects and interior designers. The aim of Question 16 was to explore how important both groups of participants felt ingredient transparency was, and then to compare these results to the ecolabels and environmental values the participants had already identified as important in previous questions. Results of this question are shown in Figure 5.25

Of responding architects and interior designers, 64% of both (n=35 architects, n=52 interior designers) stated that material ingredient disclosure is, "very important; all ingredients must be disclosed." While this seems a very positive response for the sustainable building industry, when considering the limited number of materials with full ingredient disclosure, it is highly doubtful that the respondents only specify materials with ingredient transparency.

There were 55 architects who responded to this survey question, 64% (n=35) of whom stated that "all material ingredients must be disclosed" with 69% (n=24) of these having a sustainable design designation. Of the 81 interior designers who responded to this question, 52 of them (64%) stated that "all material ingredients must be disclosed" with 42% (n=22) having a sustainable design designation. Only 3 of the responding 35 (9%) architects and 8 of the 52 (15%) interior designers did not include an answer to Question 17, asking for a list of ingredient(s) that are avoided. So, although it is unlikely that all of the materials specified by these 87 professionals have complete ingredient disclosure, the high rate of architects and interior designers listing ingredients that are avoided supports the idea that many survey respondents have significant knowledge of environmentally harmful ingredients and chemicals. The Theory of Planned Behaviour could also be applied to these results: people are more likely to participate in a certain behavior driven by behavioral intentions when they have more positive attitude toward the behavior and when they perceive their significant others want them to perform the behaviour (Lee et al., 2013).

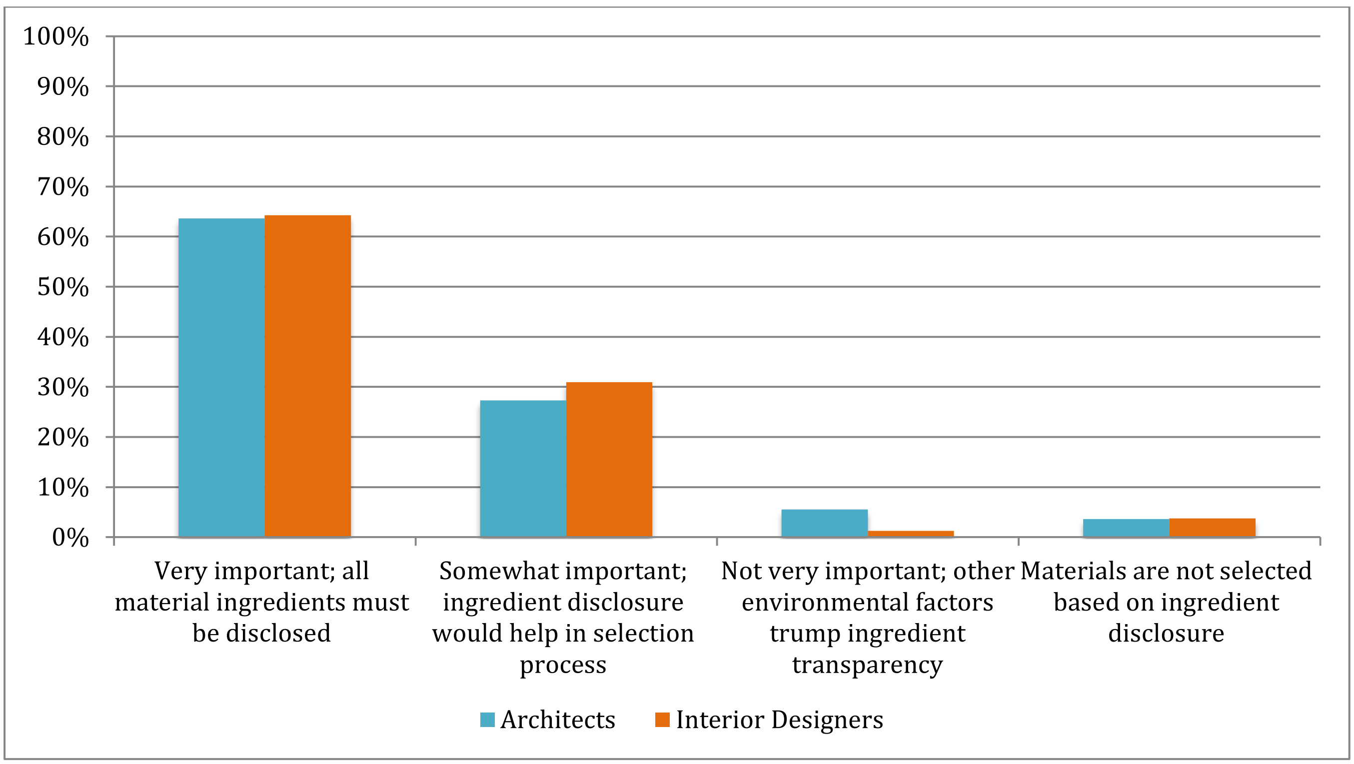

Figure 5.25: Importance of ingredient disclosure

One of the goals of this question was a comparison with the results of Question 10, "*What label and/or supporting documentation is the most important to you when specifying an environmentally preferable material.*" Of the architects who responded to this question with "all material ingredients must be disclosed," 53% (n=8 of 15) of them listed EPDs as the resource primarily used to source out environmentally preferable interior materials in

Question 10, and 53% (n=9 of 17) listed "material ingredients"; 77% (n= 17 of 22) of interior designers responded to Question 10 with EPDs and 55% (n=16 of 29) indicated "material ingredients" as the primary resource used.

Therefore, only 17 of 35 (50%) architects, and 34 of 52 (65%) of interior designers who stated that a material's ingredients must all be disclosed in order for it to be specified used labels or documentations that include material ingredient disclosure as resources for specifying materials or products. This discrepancy between how important architects and designers feel ingredient transparency is and the number of them who actually use resources which include ingredients indicates that disclosure is more of an altruistic wish, and not often practiced in reality.

- **Question 17**: *"Are there interior material ingredient(s) that you most often avoid due to adverse environmental impacts?"*

With many of the GBRS listing banned ingredients (e.g., urea formaldehyde in LEED), and the Red List identifying material ingredients and chemicals that cannot be used in LBC-certified products, this question aimed to see if architects and interior designers try to avoid specific ingredients and how these ingredients relate to current tools and systems. Eighty-two percent (n=45) of architects and 77% (n=58) of interior designers do have material ingredients that they try to avoid. Figure 5.26 illustrates the materials to avoid most frequently mentioned by architects and interior designers, with additional ingredients/comments not included in the Figure 27 are listed in Table 11. The overall conclusion from the results of Question17 indicate that indoor air quality and human heath contribute greater than environmental factors when avoiding material ingredients. Both architects and interior designers included volatile organic compounds (VOC) as the ingredient most often avoided, followed by formaldehyde and polyvinyl chloride (PVC). These top three are ingredients/materials to be avoided in the GBRS discussed in this study. The fourth overall material avoided (though not specifically an ingredient) for both groups was exotic wood, directly related to environmental degradation whether through transportation or deforestation.

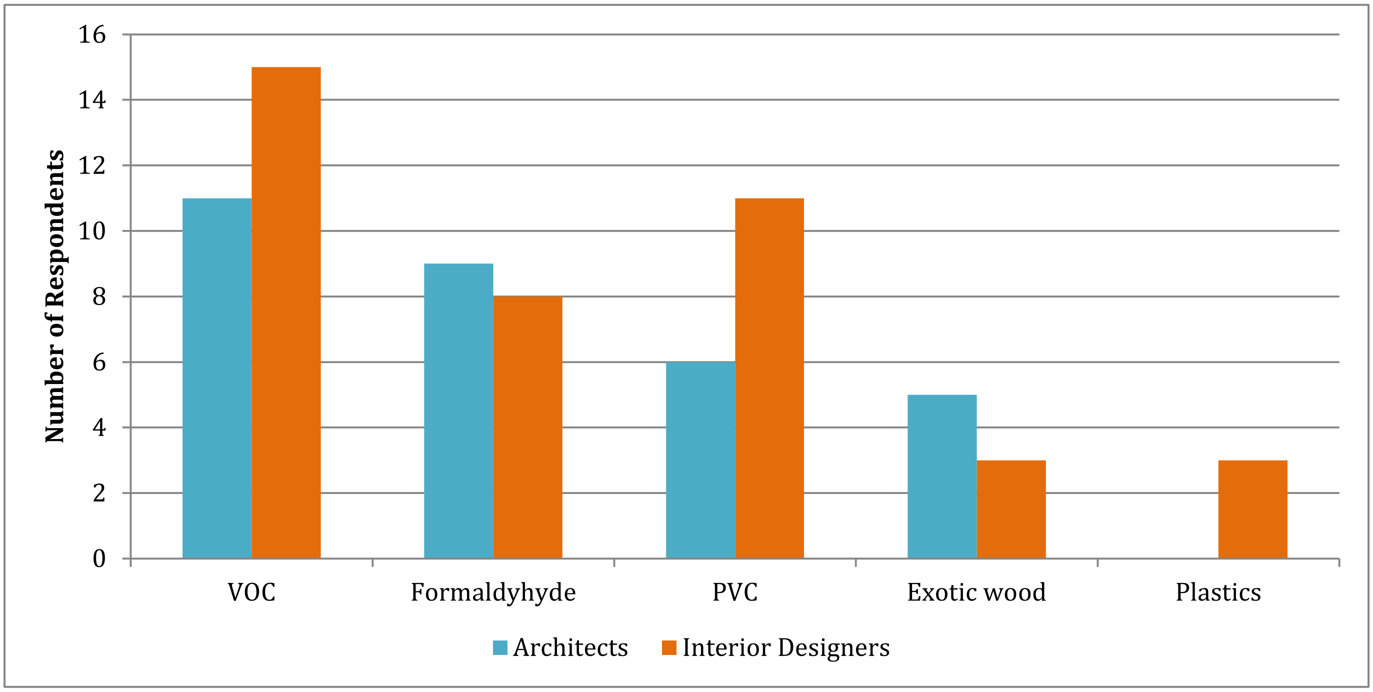

Figure 5.26: Ingredients most often avoided by architects and interior designers

The ingredients or materials listed in Table 5.6 demonstrate a diverse but educated compilation, with architects including more envelope building materials (insulation, asbestos) and also heavy metals (lead and aluminum), whereas interior designers included ingredients primarily related to interior materials and finishes (lacquers, high-VOC paints and phthalates).

Table 5.6: Ingredients most often avoided by architects and interior designers

"Other" listed ingredients/materials, listed by architects:	"Other" listed ingredients/materials, listed by interior designers:
o *Anything that isn't healthy* o *Drywall Plastics Phenol Formaldehyde binders pressure treated wood* o *petroleum* o *Heavily processed, non-renewable materials* o *Fiberglass insulation* o *Lead, mercury, formaldehyde, cadmium, toluene, asbestos, coal tar, phthalates etc.* o *Asbestos...huge list here*	o *silica, bleach,* o *concrete, manufactured counter top plastics,* o *Materials red list* o *Phthalates and other glues and plastics* o *Antimicrobials, Ortho-phthalates* o *Halogenated flame retardants* o *lacquers - oil based products* o *PVC, asbestos, non-organic plastics* o *Anything high in VOCs, Any rare*

o *lead based anything* o *any carcinogenic* o *See German federal regulations, as they are more stringent than ours, re. PVC, Mineral Fibre, Glass Fibre, etc.* o *anything with heavy metals - lead/aluminum* o *We avoid products with environmentally destructive manufacturing processes, low recycling ability, and high embodied energy.*	*wood that is not FSC cert, Materials coming from too great a distance* o *Non-Recyclable materials, VOC paint* o *Asian Pacific manufactured products* o *this is a matter of prioritizing less impactful materials over those with a greater life-cycle impact, we don't have a specific blacklist* o *Ingredients that affect air quality and / or water supply. E.g. alkyd / oil paints when there is a low-VOC alternative.* o *Asbestos, etc.*

- **Question 18**: *"Do you have experience in working with, and specifying materials for, LEED v4 Material & Resources credits?"*

Version four of the LEED building rating system included significant changes to the Material & Resource credits (MRc), including a new push for material ingredient transparency, as well as whole building life-cycle assessment, in both the Building Construction & Design (BD&C) and Interior Design & Construction (ID&C) credits. As identified in the LEEDv4 section of Chapter 2, the USGBC and CaGBC both recognize the scale of changes to v4, and so are allowing until October 2016 for LEED 2009 to be completely phased out. This question aims to explore the relevancy and adoption of the LEED v4 MR credits (credits that were include in this question are ones that are included in both BD&C and ID&C; see Appendix B, Section 1, Table B1 for the full list of credits). By this point in the survey, the number of architects responding had dropped to 56, and interior designers were down to 80. Given that LEED v4 has been in use since November 2013, the number of professionals with knowledge of the Material & Resource credits was low: 43% (n=24) of architects and 21% (n=17) of interior designers answered "yes" to having experience with these credits, as seen in Figure 5.27. Of the architects and interior designers participating in this study, 44 architects (44%) of the 101 Question 4 respondents, and 36 interior designers (35%) of the 104 Question 4 respondents, are LEED accredited. It is not known how many are LEED v4 accredited compared to LEED 2009, nor whether the respondents were accredited in LEED BD&C or ID&C. Twenty four of 56 architects (43%) and 12 of 17 (71%) interior designers who stated that they have experience working with LEED v4 MR credits are LEED accredited professionals, concluding that there is a strong connection between interior designers with LEED training and LEED MRc experience, but less so with architects.

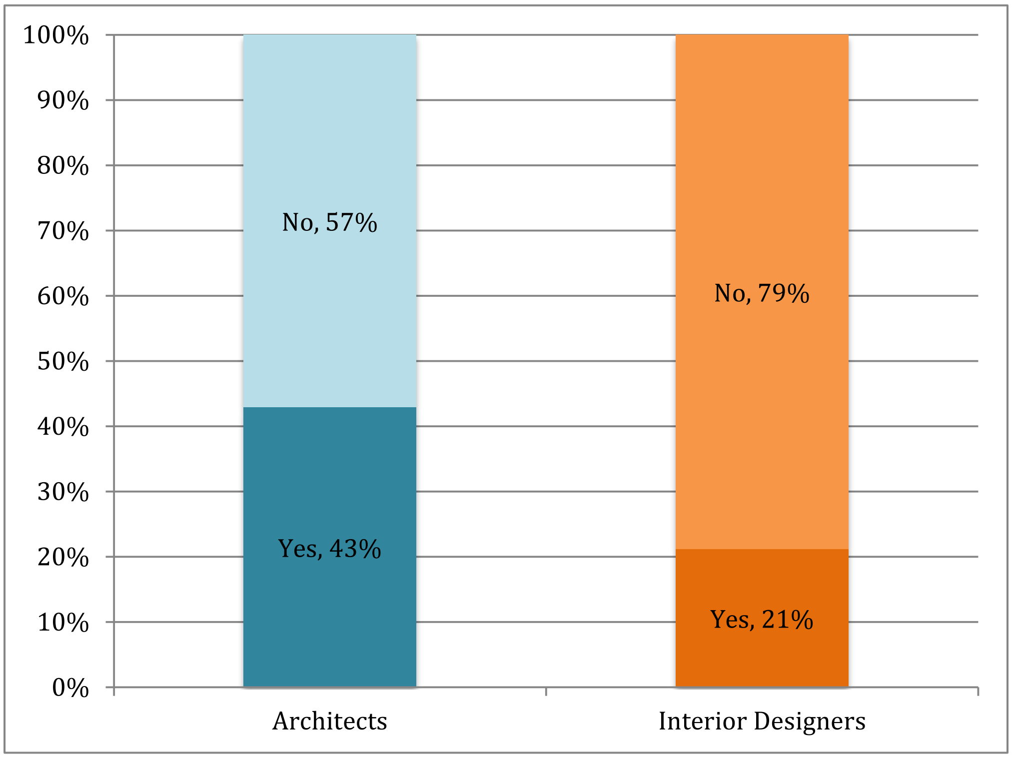

Figure 5.27: Architect and interior designers' experience with LEED v4 MR credits

- **Question 19**: *"Which of the available LEED v4 Materials and Resources credits are most commonly utilized on your current projects (or are referenced if using LEED v4 as a template for sustainable building systems) – select all that apply:"*

Participants who stated "Yes" to having experience working with Material and Resource credits in LEED v4 were asked to select which credits they most often work with in Question 20 (24 architects and 17 interior designers responded to this question). Sixty-seven percent (n=16) of architects and 56% (9) of interior designers indicated that the most utilized credit is MRc1- Building Life-cycle impact reduction, as shown in Figure5.28. Participants had the option to select all that apply for this question, yet only two interior designers (12%) selected more than one credit, whereas 17 architects (71%) selected more than one credit, 6 of whom selected all four credits. Overall, architects have more experience with MR credits in LEED v4, and a broader range of experience and utilization of the four credits with the MR category.

Of particular interest here is professionals' lack of experience working with MRc2- Building Product Disclosure & Optimization- Environmental Product Declarations, and MRc4- Building Product Disclosure & Optimization- Material Ingredients. The option for earning points with the inclusion of EPDs appears to be an accessible option for professionals, given the increasing number of manufacturers creating EPDs to support their products and the fact that an EPD does not need to be assessed, nor does the product need to show any environmental advantages to earn the credit. Fourteen of 25 architects (56%) and 4 of 17 interior designers (24%) utilize the EPD credit option. While both groups identified material ingredient disclosure as very important (≥60% for both) in Question 16, only 12 architects and 7 interior designers have experience using the material ingredient disclosure for credits with MRc4. When the results from Question 18 are compared with Question 19, they show a remarkably low rate of LEED v4 MRc adoption of credits MRc2 and MRc3 (the most relevant to this research): 25% of architects and 5% of interior designers who participated in Question 18 utilize MRc2- Building Product Disclosure & Optimization- Environmental Product Declarations, while 21% of architects and 9% of interior designers utilize MRc4- Building Product Disclosure & Optimization- Material Ingredients. Architects also have a considerably higher rate of experience with LEED v4 Material & Resource credits compared with interior designers.

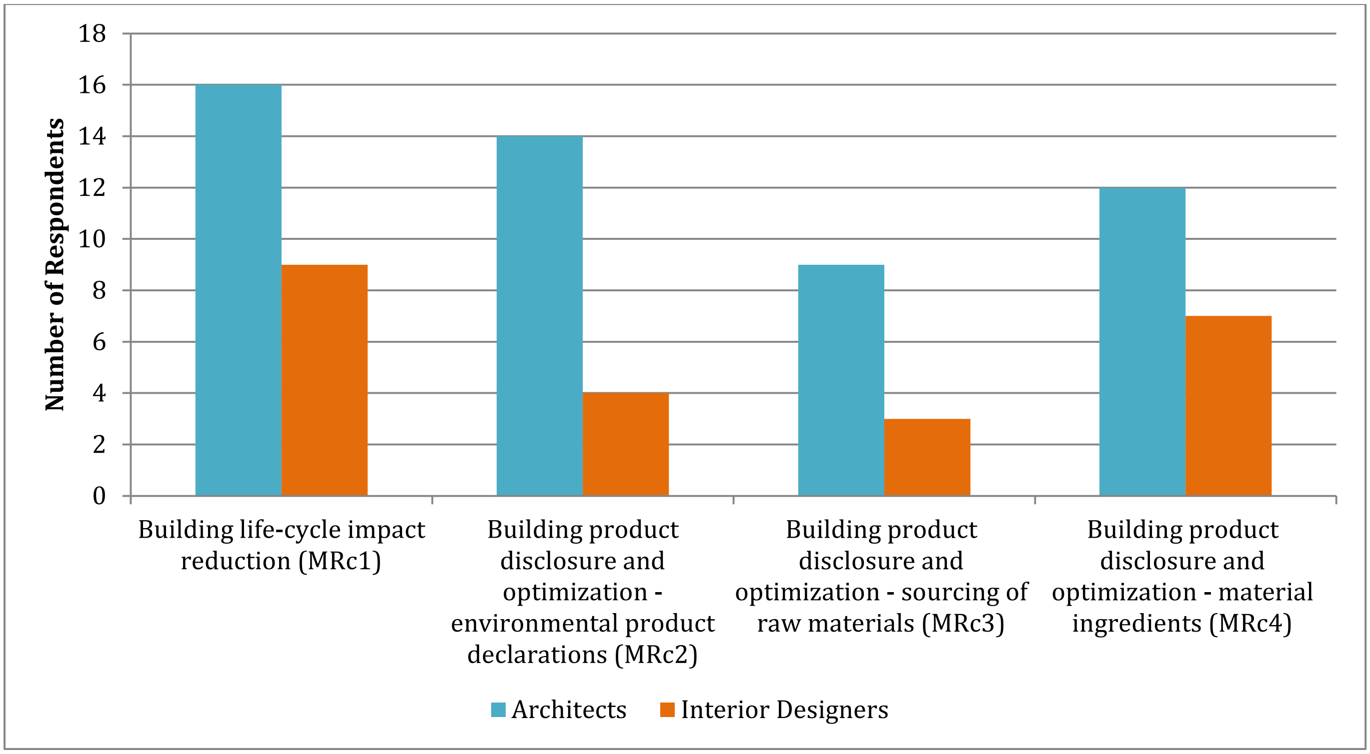

Figure 5.28: Architects and interior designers' use with LEED MR credits

- **Question 20**: *"Do you have experience in working with, and specifying materials using, the Cradle2Cradle (C2C) product certification system:"*

Unlike the results from Question 19, where architects had more experience working with and specifying materials within LEED v4, interior designers had moderately more experience specifying materials with C2C certification compared with architects (although the overall rate of experience for both was low). Fifty five architects and 80 interior designers responded to this question, with 22% (n=12) of the responding architects and 30% (n=24) of responding interior designers indicating they have worked with C2C.

An overall low adoption rate of materials with C2C certifications supports the literature which concludes that the system is challenging to work with (van Dijk et al., 2014). The responses to this question were compared to the respondents who indicated having experience with MRc4- MRc4- Building Product Disclosure & Optimization- Material Ingredients, as that is primarily where the C2C certification system will gain points within

LEED; only five of the 12 architects (42%) who work with MRc4 have experience with C2C, whereas all four (100%) of the interior designers with MRc4 experience indicated experience with C2C. This shows that architects use other options for obtaining credits within MRc4 but interior designers primarily use C2C (recognizing that four respondents provides a limited sample size).

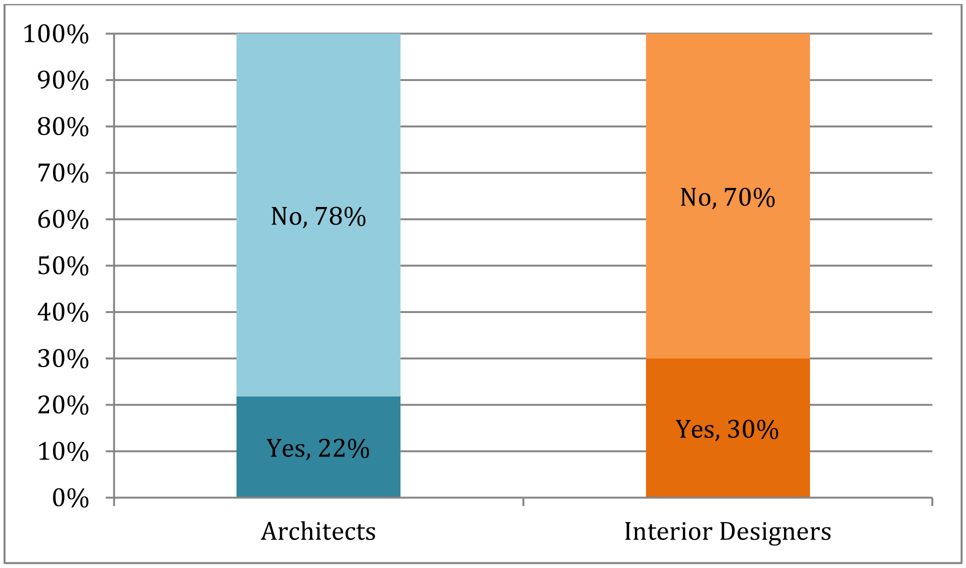

Figure 5.29: Architect and Interior Designers' experience with C2C certification

- **Question 21**: *"Do you experience barriers in specifying products with C2C certification?"*

The current literature on ecolabels and green product certifications identifies many barriers associated to using them as tools or resources in the selection of EPPs. In order to understand specific barriers experienced by the survey sample in this study, participants who responded to having experience working with either C2C, EPDs, LCAs were then asked if they also experienced any barriers when working with the system, and if so, to please identify them.

Forty-two percent of both architects (n=5) and interior designers (n=10) indicated that they do experience barriers when working with the C2C certification system, as shown in Figure 5.29 (a list of commonly mentioned barriers is included in Table 5.7, and the full list is contained in Table D3 in Appendix D). Of the five architects who stated meeting barriers with C2C, four responded a limited selection of products, while one identified cost. This is interesting, as cost was identified as a barrier to sustainable design in Questions 15 & 28. Ten interior designers identified barriers to C2C, two listing cost, two listing product selection, reinforcing the architects' barriers.

Though only a small percentage of survey participants have experience with the C2C certification system in relation to interior materials, ≥40% of those experience barriers working with the system, primarily a lack of product selection, followed by a perceived cost premium.

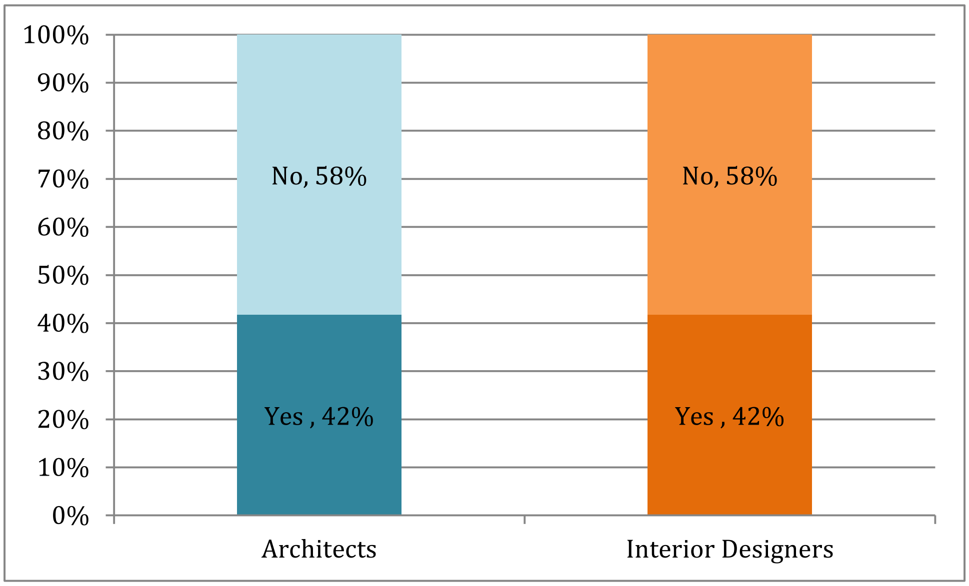

Figure 5.30: Architects and interior designer's barriers to C2C architects and interior designers

The responses to Questions 20 & 21 show that the C2C system is used by a relatively small percentage of practising architects (22%) and interior designers (30%) in Ontario, and that nearly half of those who do have experience with it feel there are barriers to implementation. Further, a strong connection between experience with C2C and LEED v4 MRc4- Building Product Disclosure & Optimization- Material Ingredients can be made for interior designers, but not for architects.

Table 5.7: Common barriers to C2C use

Barrier	**Architects (n= value)**	**Interior Designers (n= value)**
Cost	n=2	n=1
Limited Products	n=2	n=3

- **Question 22**: "*Do you have experience in working with, and specifying interior materials with EPDs (environmental product declarations):*"

Environmental Product Declarations are growing in availability and use (especially as they are earn points in the Material & Resources credit in LEED v4), and while EPDs are listed as a response option in Question 10, it is of value to identify the number of professionals who have worked with EPDs directly. Fifty five architects and 79 interior designers responded to this question, with 21 architects (38%) and 22 interior designers (28%) stating they have experience with EPDs, displayed in Figure 5.31. When specifying interior materials, architects have more experience with EPDs than C2C, interior designers have slightly less.

The use of EPDs within LEED v4 is leading to more manufacturers having EPDs created to support their interior materials, and so a relationship between LEED accreditation and EPD use is expected. Of the 21 architects who have experience with EPDs, nine (43%) are LEED accredited, and of 22 interior designers who work with EPDs, nine (41%) are LEED professionals. There is an interesting disconnect with those who work with EPDs, and how many of them use the LEED v4 MRc2- Building Product Disclosure and Optimization - Environmental Product Declaration credit: only six of 21 architects (29%), and three of 22 interior designers (14%) utilize MRc2. Also, only three of these architects and one of the designers are LEED accredited. Both of these data points show that although EPDs are now available for credit within LEED, they are seldom used.

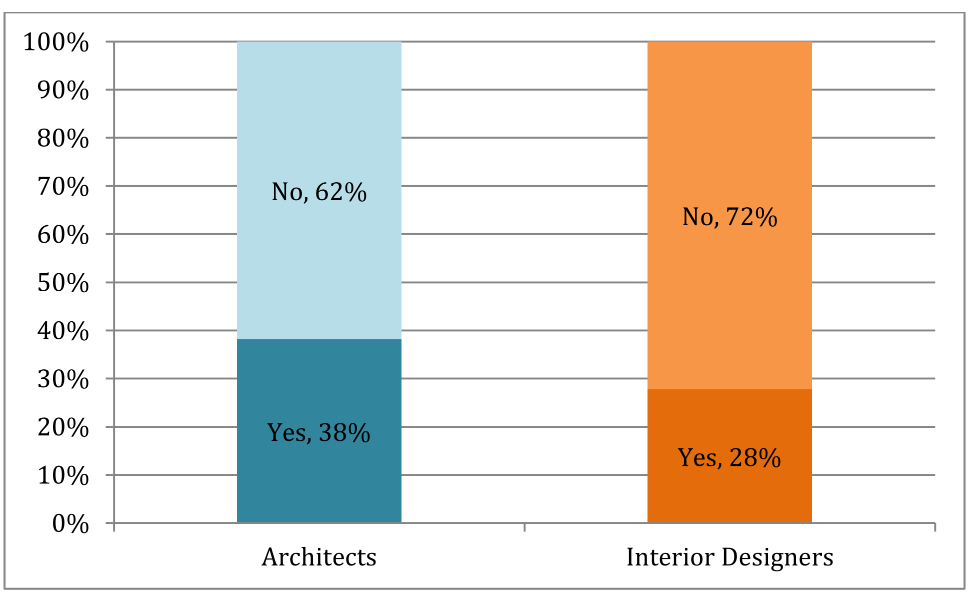

Figure 5.31: Architect and interior designers' experience with EPDs

Responses to this question indicate that architects have more experience with EPDs than interior designers (though 34% is still low), and while there is somewhat of a connection between EPD use and LEED, the majority of professionals with EPD experience are not LEED accredited, and do have experience working with EPDs for the credits available in MRc4 within LEED v4, making the connection between increased use of EPDs due to LEED credits a week one, at best.

- **Question 23**: *"Do you experience barriers in specifying products with EPDs?"*

Nearly half of the responding architects (48%) indicated experiencing barriers when specifying materials with EPDs (10 architects), compared to 24% (5) of responding interior designers. Results are displayed in Figure 5.32, with commonly mentioned barriers listed in Table 5.8 (the full list can be found in Table D4 in Appendix D). The main barrier included for both groups of respondents is a lack of consistency and comparability from manufacturers in EPDs, and both groups mention quantity of products with a supporting EPD as a barrier.

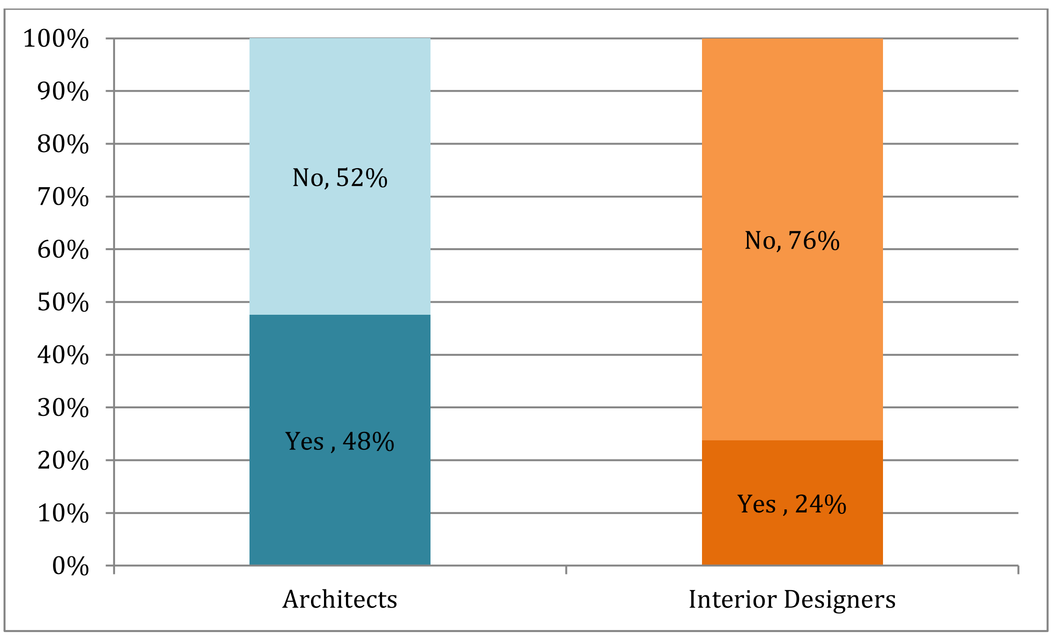

Figure 5.32: Architects and interior designers' experiencing barriers to EPDs

Table 5.8: Common barriers to EPD use

Barrier	Architects (n= value)	Interior Designers (n= value)
Cost	n=4	n=0
Uptake/availability	n=5	n=3
Trust	n=2	n=1

- **Question 24**: "Does the availability of an EPD assist in selecting an environmentally preferred interior material?"

The relevance of EPDs has been questioned by industry, as they do not provide any environmental benefits or preference over products without EPDs. Even the USGBC recognizes that EPDs are a stepping stone towards greater transparency, and are only in an early stage of development. The goal of Question 24 was to explore whether the inclusion of an EPD helps an architect or interior designer select an environmentally preferred material. Only those who answered "Yes" to Question 22 (i.e., having experience with EPDs) were respondents to this question, and the overwhelming response for both architects and interior designers was "Yes": 91% of architects (n=19) and 90% of interior designers (n=18) stated that an EPD assists them in selecting an environmentally preferable interior material. So, although there is debate as to whether the increase of EPDs is actually increasing specification of materials that are environmentally preferable, they clearly are relevant in assisting architects and designers specify materials in Ontario. However, given an EPD does not mean a material has any environmental benefit over one without an EPD, this response does not show that better materials are actually being specified.

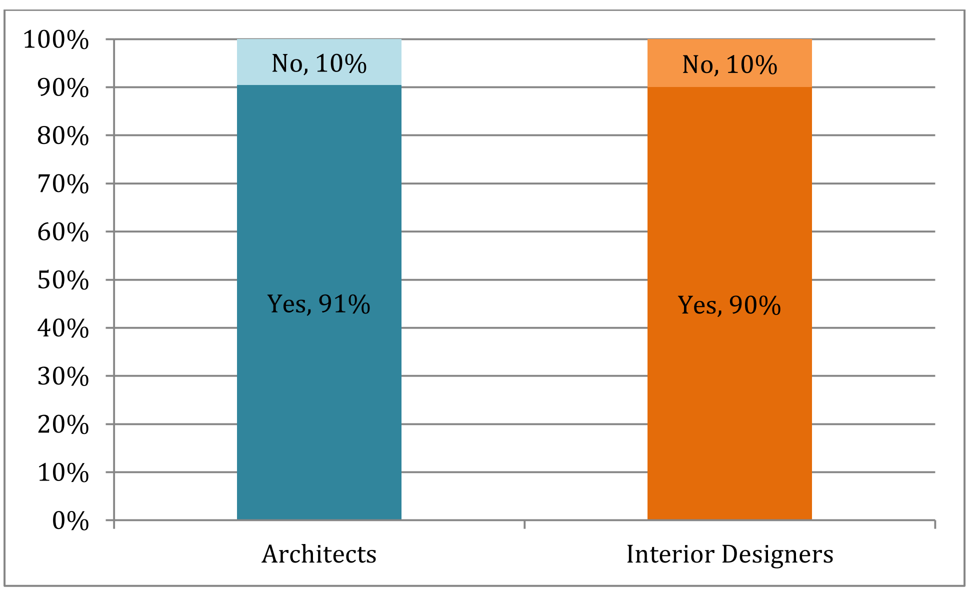

Figure 5.33: Influence of EPD in specification process

- **Question 25**: "*Do you have experience in working with, and specifying interior materials with LCAs (life-cycle assessments):*"

The final environmental documentation related to environmentally preferred materials addressed was Life Cycle Assessments (LCAs). Many ecolabels and GBRS, LEED and LBC included are beginning to address the complete lifecycle of products rather than individual stages or impacts. Fifty five architects and 78 interior designers responded to this question, and, consistent with the low rate of experiences with LEED v4 MRc credits, C2C, and EPDs, more than 50% of total respondents did not have experience working with LCAs, as illustrated in Figure 5.34. Twenty two architects (40%) and 29 interior designers (37%) stated that they have worked with LCAs when selecting interior materials, and of these, 12 architects (55%) and 12 interior designers (41%) have LEED accreditation. The LEED v4 Material and Resources credit that is most relevant to LCAs is MRc1- Building Life-Cycle Impact Reduction: 11 architects (50%) and 7 interior designers (24%) with LCA experience also indicated experience in working with MRc1.

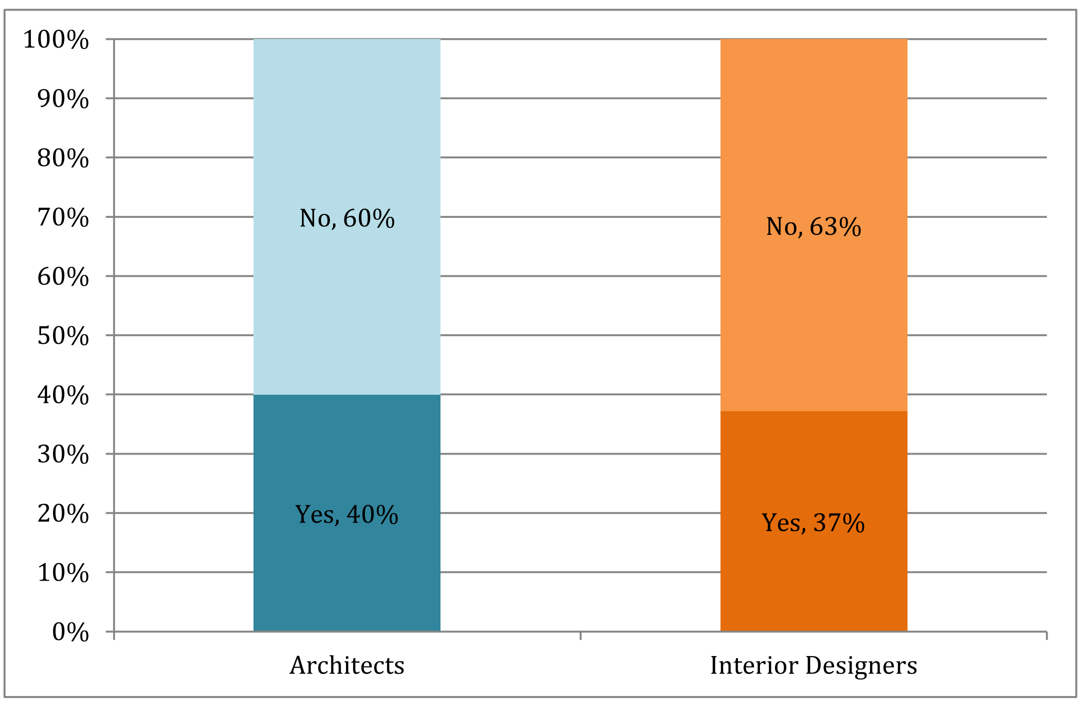

Figure 5.34: Architects and interior designer's experience with LCAs

- **Question 26**: *"Do you experience barriers in specifying products with LCA reports?"*

Of the three questions asking participants if they experienced barriers in working with C2C, EPDs, or LCAs, this question on LCA had the lowest number of positive responses: seven architects (32%) and eight interior designers (29%) indicated "yes," displayed in Figure 5.35. This is a curious finding, as LCAs are the oldest of the three systems, so it might have been expected that more professionals would have experience with LCA. However, the length and complexity of LCA reports are already identified as barriers to use. Six architects and seven interior designers listed a barrier to use: three architects listed cost as a barrier and both groups identified the limited amount of products with LCAs (a theme consistent across C2C, EPDs, and LCAs). Knowledge of the LCA methodology (as well as time to research) was also listed. The commonly mentioned barriers are presented in Table 5.9, with a full list contained in Table D5 in Appendix D.

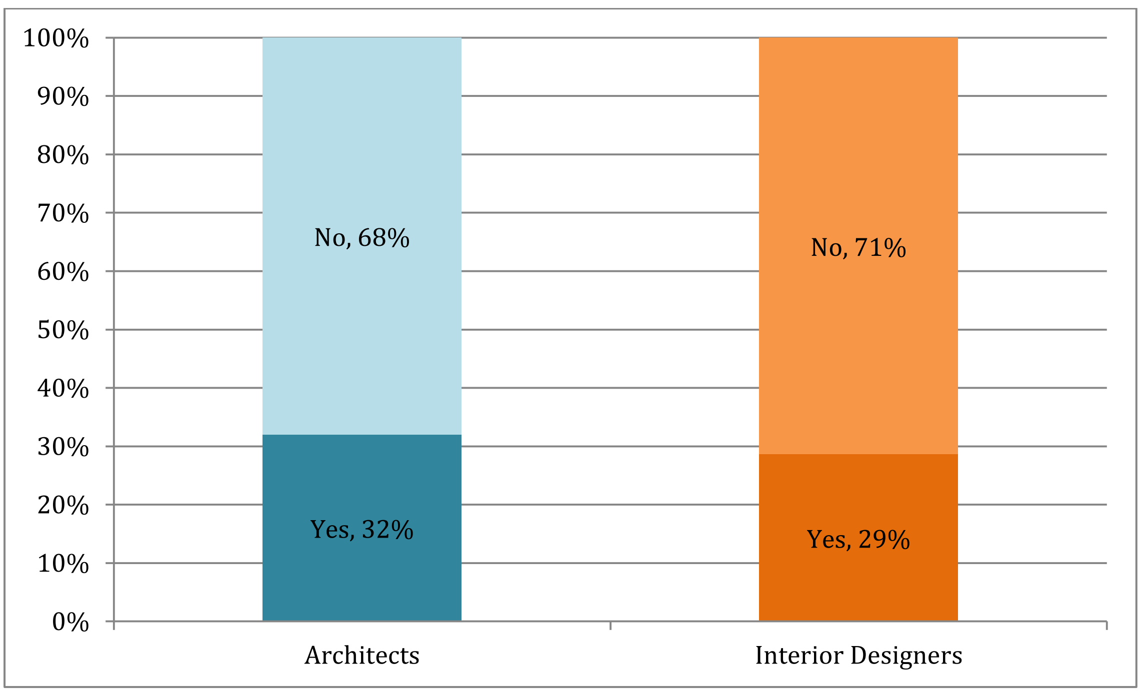

Figure 5.35: Architects and interior designer's experiencing barriers to LCAs

Table 5.9: Common barriers to LCAs utilization

Barrier	Architects (n= value)	Interior Designers (n= value)
Cost	n=4	n=0
Uptake/availability	n=3	n=3
Trust	n=0	n=2

- **Question 27**: "*Does the availability of an LCA report assist in selecting an environmentally preferred interior material?*"

The majority of architects and interior designers feel that an LCA reports helps them in selecting environmentally preferable materials: 17 architects (81%) and 23 (82%) of interior designers responded "Yes" to this question, displayed in Figure 5.36. So while more than 60% of those surveyed do not have experience with LCAs, those who do use LCAs feel they are a tool that helps them in the selection process.

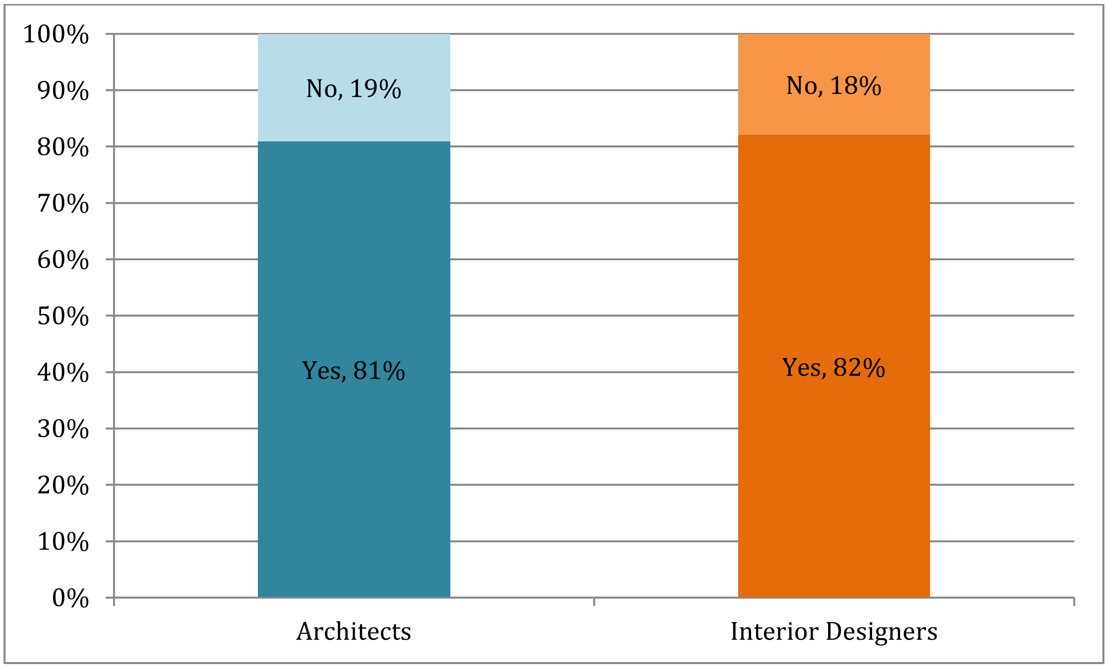

Figure 5.36: Influence of LCA in specification process

- **Question 28**: "*What do you feel are the biggest barriers to specifying environmentally preferred interior materials (select all that apply):*"

The final question was an opportunity for participants to summarize what they felt were the biggest barrier(s) to greater specifications of environmentally preferred materials (they were able to choose all answers that apply). The spectrum of answers provided was deliberately broad, with cost intentionally omitted, as numerous studies have already identified cost (or additional cost, perceived or otherwise) as the greatest obstacle to sustainable design. The results to Question 28 are in displayed in Figure 5.37.

Survey participants who had no experience working with sustainable materials (those who answered “none” to Question 6, 16 architects and three interior designers), skipped Questions 7 through 27, but were asked to complete this question. 69 architects and 81 interior designers responded to this question. The large number of participants who selected more than one of the listed barriers indicates that both groups believe there are many obstacles related to specifying environmentally preferable interior materials. Forty three of the 66 architects (65%), and 52 of 81 interior designers (64%), selected more than one barrier. Two architects and two interior designers selected all six barriers, but three of the four included a listed “other” barrier, dispelling the thought that they may have just selected all without thought or reflection.

The barrier identified by 57% (n=46) of interior designers was “not required to meet project/client requirements,” with this response tied with “no common or clear product label(s) or standard(s)” for the biggest barrier for architects as well (30 architects, or 44% for each). The second biggest barrier for interior designers was “no common or clear label(s) or standard(s) Similar to question results throughout the survey, architects and interior designers’ responses are almost identical, making problems, conclusions and opportunities relatable to both groups.

The barrier that had the greatest impact for the research questions of this work was “unclear of product certification processes,” as it aimed to summarize the experiences and barriers explored in many of the questions. If it had been rated as the biggest barrier, the conclusions may have been different. However, the number of participants who did include “unclear of product certification processes” is not insignificant: 23, or 35% of architects, and 26, or 32%, of interior designers included this as an obstacle to sustainable interior material implementation.

The “lack of information on benefits” barrier had the lowest number of responses (29% architects (n=20) and 21% interior designers (n=17)), indicating most are aware of the benefits of sustainable design. This offers reinforcement for the conclusions from the client-related questions: if between 70-80% of architects and designers feel knowledgeable about the benefits of environmentally responsible design and environmentally preferable interior materials, it is an opportunity to educate clients and to gain their support and investment. At the same time, it is important not to ignore the 20-30% of respondents who did indicate “lack of information on benefits” as a barrier. This implies a large group of practitioners nationally if this sample is representative, and thus indicates an opportunity for education and exposure of environmentally responsible design and materials specification.

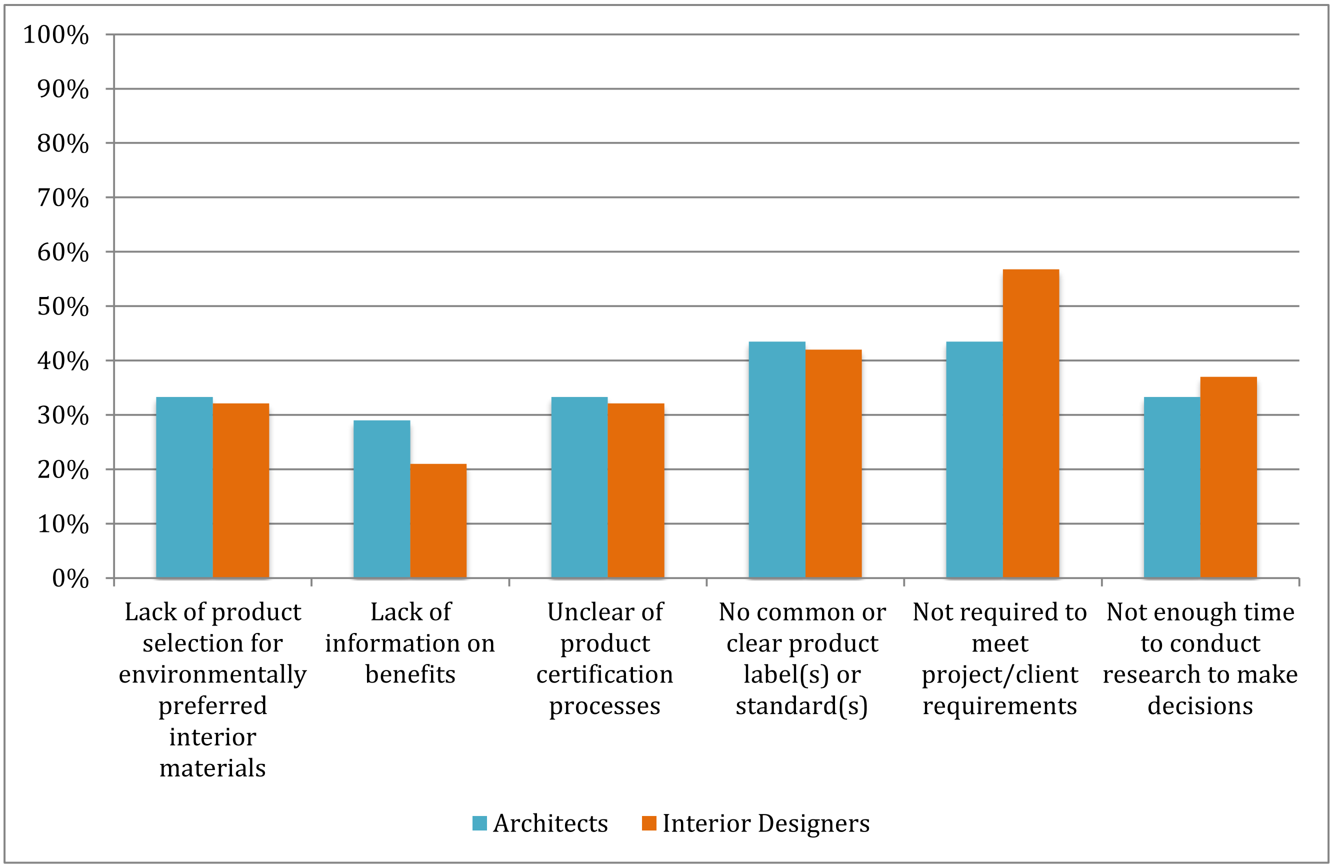

Figure 5.37: Biggest barrier to green material specifications

Participants has the opportunity to select “other” and include a barrier which was not included in the prepopulated list; it was assumed that cost would be the biggest overall “other” barrier, which was correct: 5 architects of 13 (38%), and 10 interior designers, of 21 (48%), listed cost as the barrier, supporting the already published research on cost premiums as obstacles for greater sustainable design. The common “other” responses can be found in Table 5.10, with the full list of other barriers included in Appendix D, Table D6.

Table5.10: “Other” barriers to green material adoption

Barrier	Architects (n= value)	Interior Designers (n= value)
Cost	n=5	n=6
Product availability	n=1	n=4
Trust	n=3	n=3

6. Chapter VII- Discussion & Conclusion

Decreasing the impact of building materials is a critical component of reducing the overall environmental burden of buildings. This decrease is a consequence of meeting well-designed green building standards and international GHG emissions protocols, but will also create healthier interiors for building occupants. With an abundance of sustainable design guidelines, green building rating systems (GBRS), material ecolabels, and certification methodologies, architects and interior designers are faced with the enormous task of successfully carrying out designs that are truly sustainable. Recognizing both the influences and challenges with the current decision making processes, this study used surveys of architects and interior designers practicing in Ontario to explore the current use of GBRS, adoption of environmentally preferable interior materials through ecolabels and certification standards, and the connection between the two. The goal of this study was to understand if GBRS were leading to stronger specification of environmentally preferable interior materials, to assess the relevancy of ecolabels and product certification systems in their use, and assess and compare the values, experiences and decision making-processes of architects and interior designers.

6.1. Relevancy & Use of GBRS, Ecolabels and Resources

The first major conclusion of this study is that the amount of sustainable or green interior materials specified by architects and interior designers was low: greater than 50% of both groups stated that less than 50% of the materials they specified in the last two years were certified as green or sustainable, with 16% of architects and 3% of interior designers stating that none of the materials they specified were green. Though both groups indicate material ingredient disclosure as very important, and despite many respondents being knowledgeable in which ingredients are environmentally detrimental, in practice there are significant barriers to implementation of environmentally preferable interior materials.

One of the questions in this study was looking at the relationship between GBRS and specification of environmentally preferable interior materials, so understanding the level of training and education from the participants, specifically with GBRS, was important.

Nearly half all the architects and interior designers who completed the survey had a green building accreditation or certification. However, a consistent relationship between participants with sustainable training and experience working with the tools or systems (LEED v4, C2C, LCAs, EPDs) was not evident, leading to the conclusion that professional accreditation does not necessarily lead to an increase in the specification of environmentally preferable interior materials.

An objective of this study was to try and identify an ecolabel and/or certification system that is commonly utilized across both professions, providing insight into the effectiveness of these resources. However, the result from both Questions 9 and 11 indicate that there is not a tool or system that is adopted by a majority of practitioners; the ecolabel most utilized in interior material specifications was FSC, with less than 1/5 of responding architects and interior designers (19%) indicating this as the most often specified ecolabel (the inclusion of FSC within the LEED system is likely a large factor in it ranking). The data also indicate that single-attribute labels are specified only slightly more than multi-attribute, suggesting single-attribute labels may have more influence. While the LEED green building rating system clearly has the highest amount of architects and interior designers working with it, and training as accredited professionals, the same high adoption is not true for ecolabels and product certification systems. This may indicate a market opportunity for either existing labels and systems to market the benefits and adoptability of their system to architects and interior designers, and/or a space for a new ecolabel or certification system to capture more market share.

The fact that nearly two-thirds (63%) of participants used manufacturer's literature to source environmentally preferred interior materials is aligned with previous findings. Kang & Geurin (2009) found that designers relied heavily on manufacturers' literature because of its accessibility, as fast and easy access to material data was considered an important factor in material choice. However, this reliance on information from a manufacturer is in opposition to the fact that greater than 60% of architects and interior designers stated that all material ingredients must be disclosed for all of the materials they specify. If greater than 60% of respondents require all materials ingredients to be disclosed, with assessments performed by a third party and presented in the form of either LCA, EPD, or C2C certification, architects and designers would not need to use potentially untrustworthy manufacturer's literature, and the number of certified green interior materials specified should not be less than 50% as the survey results show. All of these survey insights on the small amount of materials specified, the result of a process where participants gather information to select sustainable materials, and the stated importance of material ingredient disclosure suggest a strong disconnect in the specification process. Participants may have been subject to response bias (i.e., indicating material ingredient disclosure is used more often than it is), or from the Theory of Planned Behaviors (introduced in Section 3.6), the subjective norm behavior (perceived pressure for sustainable design, may have blurred intention and experience). These behaviors are being suggested casually, as the focus of this study and author is not of psychology, however it is important for this scope to identify the dichotomies between theory and practice. The conflicting outcomes from these questions would be of valuable research in future studies on ecolabels in the built environment.

The study also contributes to an understanding of the connection between green building rating systems and ecolabels/green product certifications as they become more and more linked. In highlighting that, the connection between the two is weak for practicing professionals, this study identifies an opportunity for great improvement.

6.2. Environmental Values and the Relationship to GBRS & EPP Labels and Systems

Responses related to architects' and interior designers' environmental values indicate that performance/durability and performance/life-cycle are the most important factors used when selecting materials that have an ecolabel, in agreement with Hossaini & Hewage (2012) who identified that material durability (life time) is an essential element of sustainability. This finding relates to the lifecycle approach to design and with LCAs being adopted into GBRS, though performance and durability are not addressed in the most used ecolabels and certification systems. The conclusion here is that ecolabels and product certification systems are not aligned with the values of those who have the most potential to use them. A recommendation in order to align the professional values with the decision making tools would be creating a very clear single-attribute ecolabel or certification which identifies only the performance and/or durability of a product. While this could be deducted from an LCA, the findings of this study would suggest that a clear and aggregated format would lead to the highest rate of implementation.

While performance and durability were most important when researching products to meet environmental criteria, indoor air quality/toxicity is the most important factor in their professional opinion, and it is also their clients' most important environmental value. These contrasting values identify a need for stronger comparability within ecolabels and product certifications, whether regulated by a standards organization like ISO, or presented in a standardized and summarized format. Also, it is important to recognize that architects, interior designers, and clients all value the health impacts of material/ingredient more than environmental impacts. Manufacturers, GBRS, product certification systems, and eco-databases may be able to strengthen the alignment between these two imperatives, leading to greater specification of more sustainable materials and supporting both environmental and human health.

Another conclusion from this study is that clients rarely request sustainable design solutions, a theme that was consistent across many of the survey questions. The majority of architects and interior designers stated that a client request for a project to meet some sustainable design mandate comes less than 25% of the time, and less than 10% of architects and interior designers specified that motivation for specifying environmentally preferred products came from the client. Nearly 50% of survey respondents indicated that a sustainable design solution was not required to meet project or clients requests (which are one and the same), and thus is the biggest barrier to specification of environmentally preferred materials. While this conclusion may be disconcerting, it also raises awareness of the opportunity architects and interior designers have to educate their clients on the benefits of environmentally responsible design, gathering stronger client (and/or stakeholder) buy- in early on in the design process, supporting the environmental solutions throughout the process. The same opportunity exists for companies and organizations to educate the consumer on the benefits, which would also increase the interest and requests from the client.

This research shows that the most common motivator in specifying green materials for those surveyed was “personal values,” indicating some humanity in practitioners in a technical, challenging, and often controversial field. When a professional has a personal investment in creating buildings which tread more lightly on the environment (suggested in studies by Hoffman & Henn 2009, Lee et al. 2013, and Sörqvist et al. 2015), there seems great potential for change.

6.3. Path to Transformation

As in most academic research, one of the goals of this work was to contribute meaningful information to the current body of knowledge, and to create positive change in practice. This study has the potential to do both. The field of green building is changing rapidly, and will continue to do so as the world continues to respond to the changing climate, as building technology improves, and as both building professionals and their clients understand the importance of building efficient and responsible spaces. This research can be used to help shift the current underutilized state of green building rating systems, tools, and resources to processes that are trustworthy, widely adopted, easier to understand and compare and that offer measurable environmental benefits. Some steps on the path to transformation of the green building industry, based on the results of this research, are presented below.

6.3.1. Standardized labeling system

Both the literature review and the results from this research indicate that a material labeling system that provides concrete and comparable environmental benefits to architects and interior designers, but also their clients, is needed in the current marketplace. This label needs to address the most important environmental factor: the performance and durability of a material. Given that both architects and interior designers overwhelmingly ranked performance as the most important (which also translates into end-of-life considerations), this label needs to address the durability and service life of the product, as well as the end-of-life options. This label could also include results of a life cycle impact assessment, as well as either full disclosure of all harmful materials, or a score based on the harmful ingredients.

Lack of transparency and trust were identified as barriers to the utilization of green building labeling systems, tools, and resources; many architects and interior designers who responded to the survey indicated that greenwashing or lack of trust kept them from working with ecolabels and methods. Yet, the majority of respondents use manufacturer's literature as their primary source of product information when sourcing a sustainable material. This duality likely only furthers the sense of distrust; manufacturers are trying to sell their product, with their published information and environmental benefits being subjective and more favorable than an impartial accounting might find. Therefore, the new standardized labeling system must be ISO type III and verified by a trusted source, to prevent greenwashing and remove lack of trust as a barrier to the specification of environmentally preferable materials.

Without mandatory regulation and standards, it is likely that many buildings (either with the input of architects and interior designers or without) will continue to be built to very low environmental standards, with adverse effects on both human and environmental health. This is where the government can play a large role in shifting the currently low use of green building techniques. by requiring all buildings and interiors to meet a minimum sustainability rating. This new standardized labeling system, designed to reflect the current state of knowledge and the results from this study, should be created and managed by the government, or else created by an independent and not-for-profit organization and mandated by the government. Specifically, this mandate would require that all interior materials carry the standardized label, offering ease in comparability and transparent, trustworthy environmental benefits to anyone choosing building materials.

A new label that is verified to have environmental benefits over its conventional counterparts, certified through a transparent process, and required for all interior materials by government initiative, there is great potential to increase the amount of sustainable interior materials used in buildings .

6.3.2. Mandatory education for professionals

A significant barrier to stronger selection of environmentally preferable interior materials identified in this study is the lack of environmental design education or training required as continuing education (CE) for both architects and interior designers. Given that both professions are required to complete continuing education hours over a two-year period (70 hours for architects and 30 hours for interior designers), mandatory CE hours in sustainability could decrease the number of architects and interior designers who respond that the biggest barrier to specifying environmentally preferable interior materials is “Lack of information on benefits” or “Not enough time to conduct research to make decisions.” Knowledge of the processes and benefits of sustainable design and material selection could also provide more buy-in from clients. Programs designed with the OAA and ARIDO, possibly with support from the CaGBC, could provide the education that professionals require so that they are truly engaged and concerned with the current state of the environment and the impacts that buildings have on it. This engagement would begin to eliminate the client not requesting, or “caring” as some respondents stated, as the architects and interior designers educate their clients on impacts from buildings and benefits from sustainable design solutions. Education will also play an important role in the deployment of the new labeling system.

6.3.3. Economic Incentives

Cost has been identified in both the literature review and the survey results of this studyas one of the greatest barriers to sustainable design and green material specification.What this suggests is that there is an opportunity to use economic incentives to help shift the issue of cost from being an obstacle to a motivator. These incentives could be approached by instituting a fee on materials that carry high environmental impacts (whether through harmful ingredients, high resource use/embodied energy or limited lifespan), or by providing a discount or subsidy for materials with low and verified environmental impacts. Again, a standardized system and/or label would be required to enable building professionals and consumers to understand the cost benefits or burdens from selecting certain materials, and these systems would be required to be implemented across the most segments possible (i.e., retail, wholesale, etc.). These types of programs have been employed in the electronic, energy, and automobile sectors, and given the large environmental impact of the built environment, similar programs should be used for buildings as well.

6.4. Final Conclusions

In conclusion, although most architects and interior designers feel strongly about many current issues in sustainable design and green interior materials, there are significant deficiencies in the adoption of tools, systems, and resources available to assist in greater specification of sustainable interior materials. Regardless of the inclusion of ecolabeling systems and/or product certification tools in current versions of GBRS, this addition does not lead to stronger sustainable interior material specifications. In fact, this study shows that the most relevant ecolabels, environmental performance tools and eco-databases are rarely used by architects and interior designers, and that there is not an ecolabel or tool that is used consistently from a large number within both groups. Lack of client interest and requests is significant and could be partially responsible for such low adoption, more training and interest from architects and interior designers would likely lead to higher use of these products and resources, therefore greater specification of environmentally preferable interior materials, while lessening the environmental impacts of the building industry. While the transparency movement has momentum on paper, it has little momentum in practice, so there is much to be done in disclosing of materials' ingredients.

Though the results of the survey show deficiencies and disconnects, there is also significant interest and awareness into sustainable design, GBRS and environmentally preferable interior materials from architects and interior designers in Ontario. This provides great potential and many opportunities for a shift in practice to occur resulting in better decisions that improve environmental and human health impacts and lighten the overall burden of interiors and buildings on the environment.

References

Ahn, Y. H., Pearce, A. R., Wang, Y., & Wang, G. (2013). Drivers and barriers of sustainable design and construction: The perception of green building experience. *International Journal of Sustainable Building Technology and Urban Development*, *4*(1), 35-45.

Anonymous. (2013). An Overview of the Living Building Challenge. *Concrete International, 35*(11), 18-20.

Anonymous (2011). EcoLogo Certifies Clover Technologies Group Printer Cartridges. Entertainment Close-up, Entertainment Close-up, April 27, 2011.

Architecture 2030. (2013b). The 2030 Challenge. Retrieved from http://architecture2030.org/

Association of Registered Interior Designers of Ontario (ARIDO) (2010). By-law No. 4. Complaints and discipline procedure by-law. (PDF).

Association of Registered Interior Designers of Ontario (ARIDO) (2016). Continuing Education credits. Personal Communication, July 21, 2016.

Atlee, J. (2011). Selecting safer building products in practice. *Journal of Cleaner Production*, *19*(5), 459-463.

Atlee, B. J., & Melton, P. (2014). The Product Transparency Movement : Peeking Behind the Corporate Veil What Is an Environmental Product Declaration ?, 1–11. BuildingGreen.com

Baer, S. (2013). LEED v4: The Age of Transparency. *Environmental Design & Construction*. Vol.16(11), pp.38-40.

Bacon, L. (2011). Interior Designer's Attitudes Toward Sustainable Interior Design Practices and Barriers Encountered when Using Sustainable Interior Design Practices.

Bakker, C. A., Wever, R., Teoh, C., & De Clercq, S. (2010). Designing cradle-to-cradle products: a reality check. *International Journal of Sustainable Engineering*, *3*(1), 2-8.

Baumann, H., & Tillman, A. (2004). The Hitch Hiker's Guide to LCA. Studentlitteratur AB.
Brown, T. (2008). Design thinking. Harvard business review, 86(6), 84.

Berge, B. (2009). *The ecology of building materials*. Routledge.

Braungart, M., McDonough, W., & Bollinger, A. (2007). Cradle-to-cradle design: creating healthy emissions–a strategy for eco-effective product and system design. *Journal of cleaner production*, *15*(13), 1337-1348.

Bribián, I. Z, Capilla, A.V., Usón, A.A. (2011) Life cycle assessment of building materials: Comparative analysis of energy and environmental impacts and evaluation of the eco-efficiency improvement potential. *Building and Environment*. 46: 1133-1140.

Canadian Construction Association (2013). Industry Statistics. Retrieved from http://www.cca-acc.com/en/information/industry-statistics. Accessed June 2 2014.

Canadian Wood Council (n.d.) Forest Products Association of Canada- Canadian Wood. Renewable by Nature. Sustainable by Design. PDF. Retrieved from http://www.kpu.ca/__shared/assets/Cover_of_Canadian_Wood_-_Renewable_By_Nature_-_Cdn_Forest_Product_Assoc_-_June_20089491.pdf. Accessed May 28 2014.

Canada Green Building Council (CaGBC) (2016)a. LEED Project Profiles. Retrieved from http://www.cagbc.org/leed/projectprofile_EN.aspx. Accessed January 15, 2016.

Canada Green Building Council (CaGBC) (2016b). Programs- Living Building Challenge. Retrieved from http://www.cagbc.org/CAGBC/Programs/LivingBuildingChallenge/CAGBC/Programs/Living_Building_Chal.aspx?hkey=b04e1897-c875-4520-8645-31f9d70bce91. Accessed February 1, 2016.

Canada Green Building Council (CaGBC) (2016c). Going Green with LEED. Retrieved from http://www.cagbc.org/CAGBC/LEED/CAGBC/Programs/LEED/Going_green_with_LEE.aspx?hkey=54c44792-442b-450a-a286-4aa710bf5c64. Accessed March 2, 2016.

Canadian Passive House Institute (CanPHI) (2016). About us. Retrieved from http://www.passivehouse.ca/about-us. Accessed January 20, 2016.

Cargo, A., 2013. An evaluation of the use of sustainable material databases within the interior design profession. Senior Capstone Project, University of Florida. Available from: <http://www.honors.ufl.edu/apps/Thesis.aspx/Download/1993

Carpenter, W. J. (2009). *Modern sustainable residential design: A guide for design professionals*. Wiley.

Charnofsky, L. (2012). *The Interrelationship Between Human Behavior and Sustainability in the Built Environment* (Doctoral dissertation, Kent State University).

Ching, F. D., & Shapiro, I. M. (2014). *Green building illustrated*. John Wiley & Sons.

Cobut, A., Beauregard, R., & Blanchet, P. (2013). Using life cycle thinking to analyze environmental labeling: the case of appearance wood products. *The International Journal of Life Cycle Assessment*, *18*(3), 722-742.

Cobut, A., Blanchet, P., & Beauregard, R. (2015). The environmental footprint of interior wood doors in non-residential buildings–part 1: life cycle assessment. *Journal of Cleaner Production*, *109*, 232-246.

Conference Board of Canada (2013). Municipal Waste Generation. Retrieved from http://www.conferenceboard.ca/hcp/details/environment/municipal-waste-generation.aspx. Accessed February 14, 2015.
Cradle to Cradle Product Innovation Institute (C2C) (2016a). Product Certification. Retrieved from http://www.c2ccertified.org/get-certified/product-certification. Accessed January 9, 2016.

Cradle to Cradle Product Innovation Institute (C2C) (2016b). Resources. Retrieved from http://www.c2ccertified.org/resources/detail/cradle_to_cradle_certified_product_standard. Accessed January 13, 2016.

Dedeo, M & Drake, S. (2014). Healthy Environments: Strategies for Avoiding Flame Retardants in the Built Environment. Perkins +Will.

Dwaikat, L. N., & Ali, K. N. (2016). Green buildings cost premium: A review of empirical evidence. *Energy and Buildings,* 110, 396-403.

Ebert, T., Essig, N., & Hauser, G. (2011). *Green Building Certification Systems: Assessing Sustainability-International System Comparison-Economic Impact of Certifications*. Walter de Gruyter.

European Commission, 2012a. Integrated Product Policy (IPP). http://ec.europa.eu/ environment/ipp/

Elixir Environmental (n.d.). Life Cycle Assessment. Retrieved from http://www.elixirenvironmental.com/life-cycle-assessment.php. Accessed April 2, 2016.

Felton, E., Zelenko, O., & Vaughan, S. (Eds.). (2013). *Design and ethics: Reflections on practice*. Routledge.

Ferrández-García, A., Ibáñez-Forés, V., & Bovea, M. D. (2016). Eco-efficiency analysis of the life cycle of interior partition walls: a comparison of alternative solutions. *Journal of Cleaner Production*, *112*, 649-665.

Forbes, L. H., & Ahmed, S. M. (2010). *Modern construction: lean project delivery and integrated practices*. CRC Press.

Forest Stewardship Council (FSC) International (2014). About Us. Retrieved from https://ic.fsc.org/about-us.1.htm. Accessed May 28 2014.

Forest Stewardship Council (FSC) (2007). Global Strategy Report. Retrieved from https://ic.fsc.org/global-strategy.13.htm. Accessed May 28 2014.

Foster, K., Stelmack, A., & Hindman, D. (2007). *Sustainable residential interiors*. New Jersey: John Wiley and Sons

Gale, A. (2011). A comparative study of environmentally responsible design adoption by architects, facility managers, and interior designers. Master's Theses and Doctoral Dissertations. Paper 334. Emich.edu.

Glass, Stacy. (2013). LEED v4 Includes Credits for Cradle to Cradle Certified. http://www.c2ccertified.org/news/article/leed_v4_includes_credits_for_cradle_to_cradle_certified.

Godsey, L. (2012). *Interior design materials and specifications*. A&C Black.

Goggin, P. A. (1994). An appraisal of ecolabeling from a design perspective. *Design Studies*, *15*(4), 459-477.

Golden, J. S., Vermeer, D., Clemen, B., & Davie Nguyen, M. E. M. (2010). An overview of ecolabels and sustainability certifications in the global marketplace. *Nicholas Institute for Environmental Policy Solutions. Duke University. Interim Report Document*, 10-1.

Green Globes Canada- Design for New Construction and Major Renovations v.2. 2014. Rating System and Program Summary. ECD Energy & Environment Canada Ltd. PDF.

Hankinson, M. & Breytenbach, A. (2013). Barriers that impact on the implementation of sustainable design. *Cumulus Conference: Northern World Mandate*.

Häkkinen, T., & Belloni, K. (2011). Barriers and drivers for sustainable building. *Building Research & Information*, *39*(3), 239-255.

Hossaini, N., & Hewage, K. (2012). Sustainable materials selection for Canadian construction industry: An Emergy-based Life-Cycle Analysis (Em-LCA) of Conventional and LEED suggested construction materials. *Journal of Sustainable Development*, *5*(1), 2.

Hayles, C. S. (2015). Environmentally sustainable interior design: A snapshot of current supply of and demand for green, sustainable or Fair Trade products for interior design practice. *International Journal of Sustainable Built Environment*.

Hoffman, A. J., & Henn, R. (2008). Overcoming the social and psychological barriers to green building. *Organization & Environment*, *21*(4), 390-419.

International Organization of Standardization (ISO). Standards Catalogue- Environmental management -Life cycle assessment. Retrieved from http://www.iso.org/iso/catalogue_detail?csnumber=37456. Accessed April 13, 2016.

Jones, L. (2008). *Environmentally responsible design: green and sustainable design for interior designers*. John Wiley & Sons.

Kang, M., & Guerin, D.A. (2009a). The state of environmentally sustainable interior design practice. *American Journal of Environmental Sciences*. 5(2).pp.179-186.

Kang, M., & Guerin, D. A. (2009b). The characteristics of interior designers who practice environmentally sustainable interior design. *Environment and Behavior*, *41*(2), 170-184.

Keitsch, M. (2012). Sustainable design: A brief appraisal of its main concepts. *Sustainable Development*, *20*(3), 180-188.

Kibert, C. J. (2016). *Sustainable construction: green building design and delivery*. John Wiley & Sons.

Kosik, W. J. (2008). Get a life (cycle). *Consulting - Specifying Engineer, 44*(2), 68. Retrieved from http://search.proquest.com.proxy.lib.uwaterloo.ca/docview/220596100?accountid=14906

Kubba, S. (2012). *Handbook of green building design and construction: LEED, BREEAM, and Green Globes*. Butterworth-Heinemann.

Langdon, D. (2007). The cost & benefit of achieving green buildings.

Lam, P. T., Chan, E. H., Poon, C. S., Chau, C. K., & Chun, K. P. (2010). Factors affecting the implementation of green specifications in construction. *Journal of Environmental Management*, *91*(3), 654-661.

Lechner, N. (2009). Heating, Cooling, Lighting: Sustainable Design Methods for Architects (Third Edit.). New Jersey: John Wiley & Sons, Inc.

Lee, E., Allen, A., & Kim, B. (2013). Interior design practitioner motivations for specifying sustainable materials: applying the theory of planned behavior to residential design. *Journal of Interior Design*, *38*(4), 1-16.

Lee, Y. S. (2014). Sustainable Design Re-examined: Integrated Approach to Knowledge Creation for Sustainable Interior Design. *International Journal of Art & Design Education*, *33*(1), 157-174.

Living Future- International Living Future Institute (2015). The Living Building Challenge. Retrieved from http://living-future.org/lbc. Accessed February 4, 2016.

Living Future- International Living Future Institute (2015b). Understanding the Challenge. Retrieved from http://living-future.org/living-building-challenge. Accessed February 9, 2016.

Living Future- International Living Future Institute (2015c). Registered Living Building Challenge Projects. Retrieved from http://living-future.org/projectmap. Accessed February 11, 2016.

Llorach-Massana, P., Farreny, R., & Oliver-Solà, J. (2015). Are Cradle to Cradle certified products environmentally preferable? Analysis from an LCA approach. *Journal of Cleaner Production*, *93*, 243-250.

Loftness, V., Hakkinen, B., Adan, O., & Nevalainen, A. (2007). Elements that contribute to healthy building design. *Environmental Health Perspectives*, 115(6).

Malin, B. N., Melton, P., & Roberts, T. (2014). New Concepts in LEED v4, 1–14. BuildingGreen.com

Mansour, O. E., & Radford, S. K. (2016). Rethinking the environmental and experiential categories of sustainable building design, a conjoint analysis. *Building and Environment*, *98*, 47-54.

Mate, K. J. (2009). Attitudes versus actions: Are interior designers genuinely embracing sustainable design through material selection? Paper presented at the fifth International Conference of the Association of Architecture Schools in Australia (AASA). Retrieved September 4, 2013 from http://www.academia. edu/406845/Attitudes_versus_Actions_Are_interior_designers_ genuinely_embracing_sustainable_design_through_material_ selection

Mate, K.J. (2006). Champions, Conformists and Challengers: Attitudes of Interior Designers as Expressions of Sustainability through Material Selection. Paper 0066. Paper presented at *Design Research Society International Conference*. Wonderground. 1-4 November, Lisbon.

Marjaba, G. E., & Chidiac, S. E. (2016). Sustainability and resiliency metrics for buildings–Critical review. *Building and Environment*, *101*, 116-125.

Matisoff, D. C. (n.d.) *Competition and Green Building: The Case of LEED* (Doctoral dissertation, Indiana-University-Purdue-University-Indianapolis).

Matisoff, D. C., Noonan, D. S., & Mazzolini, A. M. (2014). Performance or marketing benefits? The case of LEED certification. *Environmental science & technology*, *48*(3), 2001-2007.

McDonough, W., & Braungart, M. (2010). *Cradle to cradle: Remaking the way we make things*. MacMillan.

Mehdizadeh, R., & Fischer, M. (2012). Sustainability rating systems. *College Publishing*, *7*(2), 177-203.

Melton, B. P. (2014a). Architects Push for Clearer EPDs with 2030 Challenge. BuildingGreen.com.

Melton, B. P. (2014b). Transparency Is the Secret Ingredient in “ Declare ” Products, 1–5. (BuildingGreen.com)

Melton, P., Nadav M., Roberts, T. & Pearson, C. (2014). Finding Products for LEED v4- A Guide. Buildinggreen.com

Noonan, D. S. *How (and Why?) Certify Green? The Case of LEED* (n.d.) (Doctoral dissertation, Indiana-University-Purdue-University-Indianapolis).

Obeidat, I. M. (2013). An examination of learning and application of sustainability principles in a collaborative setting (Doctoral dissertation, Texas Tech University).

Ontario Association of Architects (OAA) (2014). Code of Ethics. Retrieved from: http://www.oaa.on.ca/the%20oaa/about%20the%20oaa/code%20of%20ethics. Accessed March 16, 2016.

Ontario Association of Architects (OAA) 2016. Continuing Education Program. Retrieved from http://www.oaa.on.ca/professional%20resources/continuing%20education/coned%20program%20requirements. Accessed July 22, 2016.

Ottman, J. A. (2011). The new rules of green marketing. *San Francisco: Barrett-Koehler Publishers*.

Pacheco-Torgal, F., Jalali, S., & Fucic, A. (Eds.). (2012). *Toxicity of building materials*. Elsevier.

Passipedia (n.d.). The Passive House Resource. The world’s first Passive House, Darmstadt-Kranichstein, Germany. Retrieved from http://passipedia.org/examples/residential_buildings/single_-_family_houses/central_europe/the_world_s_first_passive_house_darmstadt-kranichstein_germany. Accessed January 18, 2016.

Peters, S. (2014). *Material Revolution 2: New Sustainable and Multi-Purpose Materials for Design and Architecture*. Walter de Gruyter.

Richardson, G. R., & Lynes, J. K. (2007). Institutional motivations and barriers to the construction of green buildings on campus: A case study of the University of Waterloo, Ontario. *International Journal of Sustainability in Higher Education*, *8*(3), 339-354.

Rider, T. R., Glass, S., & McNaughton, J. (2011). *Understanding green building materials*. WW Norton & Company.

Royal Architectural Institute of Canada (2015). Sustainable Architecture. Retrieved from https://www.raic.org/raic/sustainable-architecture#appendix_a. Accessed January 2, 2016.

Royal Architectural Institute of Canada (RAIC). 2030 Challenge (2014). Climate Change and Architecture. Retrieved from http://www.raic.org/architecture_architects/green_architecture/2030/2030factsheet_e.pdf. Accessed August 11, 2014.

Russ, T. (2010). *Sustainability and design ethics*. CRC Press.

SFI, (2014a). Sustainable Forest Initiative. About Us. Retrieved from http://www.sfiprogram.org/about-us/. Accessed August 4 2014.

SFI. (2014b). Future Forests- 2014 Progress Report. Retrieved from http://www.sfiprogram.org/files/pdf/2014-sfi-progress-report-spreads/. Accessed August 6 2014.

Silvestre, J. D., de Brito, J., & Pinheiro, M. D. (2014). Environmental impacts and benefits of the end-of-life of building materials–calculation rules, results and contribution to a "cradle to cradle" life cycle. *Journal of Cleaner Production*, *66*, 37-45.

Sörqvist, P., Haga, A., Holmgren, M., & Hansla, A. (2015). An eco-label effect in the built environment: Performance and comfort effects of labeling a light source environmentally friendly. *Journal of Environmental Psychology*, *42*, 123-127.

Spiegel, R., & Meadows, D. (2010). *Green building materials: a guide to product selection and specification*. John Wiley & Sons.

Statistics Canada (2015). Pollution and Waste: Waste disposal. Retrieved from http://www.statcan.gc.ca/tables-tableaux/sum-som/l01/cst01/envir25a-eng.htm. Accessed February 2, 2016.

Stelmack, A., Foster, K., & Hindman, D. (2014). *Sustainable residential interiors*. John Wiley & Sons.

Stieg, C. (2006). The sustainability gap. *Journal of Interior Design*, *32*(1), vii-xxi.

Strain, Larry (2016). Buildings Materials and the Time Value of Carbon. *Environmental Building News*. Retrieved from https://www2.buildinggreen.com/article/building-materials-and-time-value-carbon?woo_campaign=bgb160420&woo_content=headline&goal=0_d558b0594a-87c0755eaa-157494493&mc_cid=87c0755eaa&mc_eid=5f724beaee. Accessed April 20, 2016.

Stryjewski, E. (2007). The Sustainable Forestry Initiative vs. The Forest Stewardship Council: Evaluating the Credibility of Competing Forest Certification Schemes. University of California, San Diego.

Treloar, G. J., McCoubrie, A., Love, P. E., & Iyer-Raniga, U. (1999). Embodied energy analysis of fixtures, fittings and furniture in office buildings. *Facilities,* 17(11), 403-410.

Tugend, A. (2008, March 15). Some blissful ignorance can cure chronic buyer's remorse. *New York Times,* p. 5.

Underwriters Laboratories Inc. (UL) (2011). Transparency and the Role of Environmental Product Declarations. White Paper. http://library.ul.com/wp-content/uploads/sites/40/2015/02/UL_WP_Final_Transparency-and-the-Role-of-Environmental-Product-Declarations_V9_HR.pdf

Underwriters Laboratories Inc. (UL) (2016a). ECOLOGO Certification Retrieved from http://services.ul.com/service/ecologo-certification/. Accessed April 14, 2016.

United Nations Paris Agreement. Framework Convention on Climate Change. Retrieved from http://bigpicture.unfccc.int/#content-the-paris-agreemen . Accessed May 17, 2016.

USEIA. International Energy Outlook 2010. U.S. Energy Information Admin- istration, Office of Integrated Analysis and Forecasting, U.S. Department of Energy, Washington, DC.

U.S. Green Building Council (USGBC) (2014a). USGBC releases LEED v4 ACPs for Canada. Retrieved from http://www.usgbc.org/articles/usgbc-releases-leed-v4-acps-canada. Accessed April 22, 2016.

U.S. Green Building Council (USGBC) (2015a). Credit Category Overview. Retrieved from http://www.usgbc.org/guide/bdc#mr_overview. Accessed March 23, 2016.

U.S. Green Building Council (USBGC) (2012). A Closer Look at Materials & Resources in LEED v4. http://www.usgbc.org/articles/closer-look-materials-resources-leed-v4

U.S. Green Building Council (USGBC) (2014b). United States Green Building Council Project Directory. Retrieved from http://www.usgbc.org/projects. Accessed June 5 2014.

van Dijk, S., Tenpierik, M., & van den Dobbelsteen, A. (2014). Continuing the building's cycles: A literature review and analysis of current systems theories in comparison with the theory of Cradle to Cradle. *Resources, Conservation and Recycling*, *82*, 21-34.

WBCSD (2010). Vision 2050: the new agenda for business. World Business Council for Sustainable Development.

Woolley, T. (2013). *Low impact building: Housing using renewable materials*. John Wiley & Sons.

Wu, Z., Shen, L., Ann, T. W., & Zhang, X. (2016). A comparative analysis of waste management requirements between five green building rating systems for new residential buildings. *Journal of Cleaner Production*, *112*, 895-902.

Yeheyis, M., Hewage, K., Alam, M. S., Eskicioglu, C., & Sadiq, R. (2012). An overview of construction and demolition waste management in Canada: a lifecycle analysis approach to sustainability. *Clean Technologies and Environmental Policy*, *15*(1), 81-91.

Yudelson, J. (2013). *Green building A to Z: understanding the language of green building*. New Society Publishers.

Zuo, J., & Zhao, Z. Y. (2014). Green building research–current status and future agenda: A review. *Renewable and Sustainable Energy Reviews*, *30*, 271-281.

Appendix A- Overview of Product Ecolabels in the Built Environment

1.1. Single Attribute Ecolabels

Ecolabels can be categorized as either single-attribute or multi-attribute standards. Single attribute labels or certifications are those which are based on a single performance or environmental attribute, such as energy or recycled content, and can range from sustainably harvested wood, VOC levels, energy reductions (compared to average products) and water reduction (compared to average reductions). And each requires more than just first-party claims; second or third-party verification are necessary to receive certifications (Rider et al., 2011). Single-attribute labels have been criticized for failing to accurately define "how green" a product is, since it is difficult to compare the environmental impact of products with two different single-attribute labels. Interesting to note that only 44% of single-standard labels have conducted an impact study to assess the effect of their certification efforts on the environment (Golden et al., 2010).

1.2. FSC Certified

Although wood is a renewable resource (most not rapidly renewable), without proper forest management and harvesting methods, its usage can lead to soil deterioration, forest degradation, and deforestation (Cobut et al., 2013). Already over half of the world's forests have been degraded, destroyed or converted to other land uses (FSC, Global Strategy Report, 5). Products that use wood, or a by-product of wood, as their primary raw material, can be certified by the Forest Stewardship Council (FSC), an "an international certification and labeling system dedicated to promoting responsible forest management of the world's forests" (FSC.org). Founded in 1993, products (wood, paper and other forest products) which have the FSC label, have been evaluated, and meet the FSC standards for both environmental and social issues. In 2005, the FSC created the FSC Global Strategy, which identifies the organizations top global priorities. They are:

Goal 1- Advancing globally responsible forest management
Goal 2: Ensure equitable access to the benefits of FSC systems
Goal 3: Ensure integrity, credibility and transparency of the FSC system
Goal 4: Create business value for products from FSC certified forests
Goal 5: Strengthen the global network to deliver on goals 1 through 4

The importance of FSC for built environments is especially relevant, as there have been recent criticisms and debates over the inclusion of FSC certified wood products in LEED certified buildings (especially in the United States, where some states have gone so far as to ban LEED certifications because they refuse to purchase and support FSC wood products.

The Forest Stewardship Council (internationally) is the only forest certification system recognized by ISEAL, a global, non-governmental organization which holds standards and codes for both social and environmental systems (through their 'Codes of Good Practice') (ISEAL Alliance, 2014). FSC has certified forests in 80 countries, with 182,936,809 hectares of forest (FSC, 2014.).

1.3. FloorScore

The FloorScore program, developed by the Resilient Floor Covering Institute (RFCI), certifies hard surface flooring materials, adhesives, and underlayments which meet indoor air quality (IAQ) standards (SCS Global, 2016). Certification of products is managed by Scientific Certification Systems (SCS), through their independent, ISO-17025 accredited laboratories, with qualifying products having point potential in LEED's indoor air quality (EQ) category, as well as BREEAM. FloorScore tests for 35 individual Volatile Organic Compounds (VOCs) specified by the California Standard Method for VOC Emissions Testing and Evaluation (Standard Method V1.1) (SCS Global, 2016). Although FloorScore is a recognizable certification standard, and included in GBRS, the scope of it relates only to IAQ (through VOC testing), and not to greater environmental burdens.

2. Multi-Attribute Labels

Multi-attribute labels, on the other hand, assess products across a range of environmental impacts, generally across lifecycle stages. Although multi-attribute labels are generally less complex than a full lifecycle assessment, they are significantly more data-intensive than single-attribute labels (Golden et al., 2010). Multi-attribute labels or certifications look at the performance of a product based on various measures of sustainability, and go beyond first-party claims, requiring either second- or third-party verification. These are complex assessments that are founded on science-based criteria for determining whether or not a product can qualify for its intended certification.

2.1. Cradle to Cradle

"Less bad does not equal good"
- Michael Braungart

Since 2005, the Cradle to Cradle Products Innovation Institute has been certifying products with their Cradle to Cradle (C2C) Certified Product Standard label. The concept of a cradle to cradle approach to design was introduced by William McDonough and Michael Braungart, and became a familiar term due to their 2002 book, *Cradle to Cradle- Remaking the Way We Make Things*. Since launching the book, a number of organizations have since been aligned to the name, including the Cradle to Cradle Certified™ Product Standard, which is how and where products apply for, are qualified by, and eventually certified as C2C.

A cradle to cradle approach of products, in any context, is based on the term "eco-effectiveness", a concept created by C2C founders Michael Braungart and William McDonough, as an alternative to the popular concept eco-efficiency. Eco-efficiency intends to increase economic output while decreasing the impact of economic activity on environmental systems. Eco-effectiveness proposes the transformation of products and their associated material flows such that they form a supportive relationship with ecological systems and future economic growth. The goal is not to minimize the cradle-to-grave flow of materials, but to generate cyclical, cradle-to-cradle ''metabolisms'' that enable materials to maintain their status as resources and accumulate intelligence over time (Braungart et al., 2007). Eco-effectiveness encompasses a set of strategies for generating healthy, cradle-to-cradle material flow metabolisms. Use of the term metabolism in this case is indicative of a similarity between cradle-to-cradle material flow systems and the internal processes of a living organism. Eco-effectiveness is modeled on the successful interdependence and regenerative productivity of natural systems. In nature, all outputs from one process become inputs for another. The concept of waste does not exist.

The closed loop approach of cradle to cradle is based on two material nutrients- biological and technical. Materials that flow optimally through the biological metabolism are called biological nutrients. As defined for cradle-to-cradle products, biological nutrients are biodegradable materials. Biological nutrients can be natural or plant-based materials, but include also materials like biopolymers and other potentially synthetic substances that are safe for humans and natural systems. A technical nutrient, on the other hand, may be defined as a material, frequently synthetic or mineral, that has the potential to remain safely in a closed-loop system of manufacture, recovery, and reuse (the technical metabolism), maintaining its highest value through many product life cycles.

The methodology for the Cradle to Cradle Certified™ Product Standard label was created by McDonough Braungart Design Chemistry, LLC (MBDC), in 2008 in cooperation with EPEA Internationale Umweltforschung GmbH, and has certified over 400 products in the last 9 years (C2Ccertified.org, 2016a). Since then, the program has gone through a number of revisions, with the latest, Cradle to Cradle Certified™ Product Standard, Version 3.1, launching in 2016 (c2ccertified.org, 2016b)

Products are evaluated across five categories- material health, material reutilization, renewable energy and carbon management, water stewardship, and social fairness, with *each* category receiving an achievement level, either Basic, Bronze, Silver, Gold, or Platinum (see Table _._ for further breakdown of the categories). The category with the lowest achievement level dictates the overall product certification level (C2Ccertified.org, 2016a); i.e., if a product scores three golds, one silver and one bronze, the product will retain an overall certification level of bronze. This rigor stands out from many of the other point-based certification systems; however it is the Cradle to Cradle Products Innovation Institute (a non-profit organization) who administers the C2C Certified Product Standard, not a third-party certification. Although products must be certified to the lowest achievement level attained in the five categories, product and product packaging, even inherent product containment, can have different certification levels, or no certification level whatsoever (e.g., a floor cleaner is certified gold, but its' packaging, "meets banned list requirements but has not been assessed to determine certification level" (c2ccertified.org, 2016c)). Another important observation of the Cradle to Cradle Certified™ Product Standard is that, as of publishing, no product has yet to be certified Platinum. Not a measure of failure, but rather of the challenges that arise creating these products.

Table A1: C2C Categories

Category	Description
Material Health	Product ingredients are inventoried throughout the supply chain and evaluated for impact on human and environmental health. The criteria at each level build towards the expectation of eliminating all toxic and unidentified chemicals and becoming nutrients for a safe, continuous cycle.
Material Reutilization	Products are designed either to biodegrade safely as a biological nutrient or to be recycled into new products as a technical nutrient. At each level continued progress must be made towards increasing the recovery of materials and keeping them in continuous cycles.
Renewable Energy & Carbon Management	The criteria at each level build towards the expectation of carbon neutrality and powering all operations with 100% renewable energy.
Water Stewardship	Processes are designed to regard water as a precious resource for all living things. At each level, progress is made towards cleaning up effluent to drinking water standards.
Social Fairness	Company operations are designed to celebrate all people and natural systems and progress is made towards having a wholly beneficial impact on the people and the planet.

The rigor, history and transparency in the C2C Certified Product Standard certification has brought this label to be recognized as one of, if the not most, valid product labels available to both manufacturers and consumers, especially as it has been adopted as a product guideline in the new LEED v4.0 (projects will be awarded points in the Materials and Resources credit by specifying C2C certified materials). There are two options for using Cradle to Cradle products to attain points; one in Materials Ingredient Reporting and one in Material Ingredient Optimization and are summarized in the Table A2 below:

Table A2: LEED v4 Summary of Cradle to Cradle product certification potential in LEED Building Disclosure and Optimization—Material Ingredient credit (Source: Glass, S., 2013).

LEED Credit Overview- Building Disclosure and Optimization—Material Ingredients	Summary
Materials Ingredient Reporting	Products whose chemical ingredients are inventoried using an accepted methodology. Understanding a product's chemical composition down to the 100 ppm is a necessary first step in working toward chemical optimization. Option 1 awards a point to projects with at least 20 permanently installed products that meet at least one of a list of criteria, one being Cradle to Cradle certification; must be

	certified “Cradle to Cradle v2 Basic level or higher or Cradle to Cradle v3 Bronze level or higher.
Material Ingredient Optimization	Minimize the use and generation of harmful substances. Encourages use of products whose chemical composition has been assessed and optimized. Projects must include optimized products comprising at least 25% of the total cost of permanently installed products. Cradle to Cradle v3 Silver certified products are valued at 100% of cost, recognizing that they contain neither Cradle to Cradle banned list chemicals nor substances considered carcinogens, mutagens, or reproductive toxins. Cradle to Cradle v2 and v3 Gold and Platinum products are valued at 150% of cost, recognizing that these products’ chemicals have been fully optimized.

2.2. GREENGUARD

The GreenGuard certification system aims to protect human health and improve indoor air quality through reducing exposure to chemicals and pollutants that are found in interior products and materials; products with GreenGuard certification have met stringent chemical emissions standards and are validated by third-party verification (Rider et al., 2011). GREENGUARD is recognized by both Green Globes and LEED, and is an ISO accredited, third-party organization which certifies interior materials and products. The GreenGuard system helps both manufacturers create interior products and materials that have low chemical emissions, and through the certified products, assists in architects and designers specify materials with low chemical emissions. UL Environment, a business unit of UL (Underwriters Laboratories), acquired GREENGUARD in 2011, further advancing its mission of promoting global sustainability, environmental health, and safety (GreenGuard, 2016).

There are two levels of certification: GREENGUARD certification, GREENGUARD for Homes and GREENGUARD Gold; the Gold rating meets higher emission standards with most products intended for schools and healthcare facilities (GreenGuard, 2016). The GREENGUARD Product guide is a free online tool that helps both professionals and consumers search through low-emitting products which have been screened for more than 10,000 chemicals.

2.3. The Living Product Challenge

Initiated by the International Living Future Institute (ILFI), and aligned with the Living Building Challenge (LBC), the Living Product Challenge (LPC), launched in 2015, "re-imagines the design and construction of products to function as elegantly and efficiently as anything found in the natural world" (ILFI, 2016), with products being informed by biophilia and biomimicry, prevalent terms in the sustainable materials movement. This visionary path to materials aims to improve the quality of life, while bringing joy and beauty through their functionality (similar to the Imperatives within the LBC). For a product to be Living Product certified, it must use locally sourced with renewable or bio based materials, and is manufactured by processes powered only by renewable energy and within the water balance of the places they are made. Further, all Living Products should neither endanger nor impair the health of those who manufacture or use them (ILFI, 2016). Certification can be achieved through three pathways: full Living Product certification (meeting all 20 petals), Petal or Imperative-by-Imperative certification, and certification is based on actual, not modeled performance.
The LPC follows the same seven petals as the LBC (Place, Water, Energy, Health & Happiness, Materials, Equity and Beauty), and though also has 20 Imperatives, they differ from the LBC imperatives. Imperatives in the Materials category aim to remove the worst known offending materials and practices from manufacturing processes, and are summarized in the table below.

Table A3: Summary of the LPC 'Material Petal' Imperatives.

Imperative	Description
Red List	The product cannot contain any of the Red List materials and chemicals (See Section 3.1.2.1 for the full list)
Living Economy Sourcing	Source locations for materials: - 10%+ purchased budget from 1000km of manufacturing - 40% purchased budget from 2000km of manufacturing - 25% purchased budget from 5000km of manufacturing - 25% purchased budget from anywhere
Responsible Industry	Advocate for the creation and adoption of third- party certified standards for sustainable resource extraction and fair labour practices within its industry -Wood or timber, 100% FSC - Agricultural- certified organic - Conflict Minerals- Conflict-Free Smelter Program assessment protocols - Cannot contain ingredients that are derived solely or in part from any animal that is classified as near-threatened, vulnerable, endangered, or critically endangered -Must have a Declare label (See Section 2.1.3.4 for details).
Net Positive Climate	Manufacturer must develop and publicly share a plan to reduce the product's cradle-to-gate climate footprint and then create a climate handprint greater than the

	footprint
Net Positive Waste	Must meet waste diversion targets during the production of the product: - Metals -99% - Paper and Cardboard -99% - Soil and Biomass - 100% - All others (combined weight) - 90% Manufacturing process may not produce any toxic by-products or emissions, or on the Red List. 100% of the product packaging must: - Completely biodegradable - Completely recyclable (without being commingled with non) - Completely reusable through take-back & reuse program - Free of Red List chemical and materials - Free of packaging that could be hazardous to marine, bird of animal life
Product Fit to Use	Product must be designed and tested to last as a useful, functioning product for at least the average lifetime for its product category, as documented in the Institute's online Product Life Database (disposal or single-use do not qualify unless 100% biodegradable)
Useful Life Disposal	Product must either be: - Free of any Red List chemicals and be completely compostable within five years. - Able to be 100% recycled. - Have a manufacturer take-back program available in the market where the products are sold.

While many believed this was a call to action with lofty, if not unattainable goals, in the current materials manufacturing landscape, on May 26, 2016, the ILFI announced it had awarded its first two products as Living Product certified; Owens Corning met the Imperative certification (13 out of 20 Imperatives) with three of their insulation products (one blown-in insulation, and two loose fill). The second product system was SIREWALL Structural Integrated Rammed Earth (a wall system made from sandstone, rebar and rigid insulation). Also Imperative certified, SIREWALL met 11 of 20 Imperatives.

2.4. ECOLOGO

The ECOLOGO product certification, formally Environmental Choice Program, was created in 1988 by the Environment Canada to help consumers, companies and manufacturers create and identify products which have been independently certified to meet strict environmental standards, based on life cycle assessment. In 2010, the ECOLOGO Certification program was acquired by UL Environment, a division of UL (Underwriters Laboratories), similar to GREENGUARD. ECOLOGO Certification is based on multiattribute, life cycle–based standards, and is successfully assessed by the Global Ecolabeling Network, appearing in over 350 specifications and standards (Underwriters

Laboratories, 2016a). All products certified to an ECOLOGO standard must meet or exceed each of the listed criteria before receiving the mark, demonstrating they carry less impact on the environment by reducing waste entering the landfill and conserving resources. The standard also includes performance criteria to ensure that certified products perform as well as others on the market (Anonymous, 2011).
ECOLOGO Certification is classified as an ISO (Type 1 ecolabel (Ecolabel Index, 2016). The ECOLOGO certification can be found across a broad range of industries; within the built environment, the EGOLOGO may appear on building materials, flooring, chemicals and plastics (Underwriters Laboratories, 2016a).

2.5. Life Cycle Assessment (LCA)

When looking at the law of conservation from an environmental angle, the principle is simple: matter cannot be created or destroyed, but rather moves through numerous processes and transformations. Buildings may be built, interiors renovated, yet all those materials are part of a perpetual cycle: used or reused, thrown away or recycled, buried or burned, yet they never really go away, as that matter existed in some form or another, before that material was ever created. This law creates the foundation of the life cycle assessment (LCA) approach to materials, products, and buildings.

Life-cycle approaches to materials assessment began in the 1960s with carbon accounting models (USGBC, 2015a), and since 1990, have achieved wide implementation in building assessments (Zuo & Zhao, 2014). Defined by Bauman & Tillam (2004) in the book, *The Hitch Hiker's Guide to LCA,* "a product is followed from its "cradle" where raw materials are extracted from natural resources through production and use to its "grave" the disposal". As defined by the USGBC in the LEEDv4 MR credits, an LCA is a, "compilation and evaluation of the inputs and outputs and the potential environmental impacts of a product system throughout its life cycle" (USGBC, 2015a). A complex and ambitious process of creating, LCAs are governed by international standard ISO 14040:2006 (last reviewed in 2010 (ISO, 2010)), and are often completed by third party groups on behalf of product manufactures. LCA can be thought of as "lifecycle costing", by replacing capital and operating expenses with energy use and environmental impacts, ideally through cradle-to-cradle, thus complementing economic accounting (Kosik, W. 2008).

The main phases of creating an LCA are goal and scope definition, life cycle inventory analysis (LCIA), life cycle impact assessment (LCIA) and interpretation (based on the established goals and scope). The results of an LCA, whether from a material ingredient, product or process, are described in quantitative terms (in the impact assessment category), and can include the following categories:

Resources- Energy and Material
Resources- Water
Resources- Land (including wetlands)
Human Health- Toxicological impacts
Human Health- Non-toxicological impacts
Ecological Consequences- Global warming

Ecological Consequences- Depletion of stratospheric ozone
Ecological Consequences- Acidification
Ecological Consequences- Eutrophication
Ecological Consequences- Photo-oxidant formation
Ecological Consequences- Ecotoxicological impacts
Ecological Consequences- Habitat alterations and impacts on biodiversity

From the onset of LCA studies, early adopters recognized one of the challenges in creating LCAs was data; both the collection or access to data, and also the storage of it. Public authorities called for public databases to be created in the early 1990s to help ease the burden of access to data, and to make the process of creating LCAs more efficient (Baumann & Tillman, 2004). Since then, dozens of global databases and software platforms (with built-in databases) have been created. The ATHENA Sustainable Materials Institute, Building for Environmental & Economic Sustainability (BEES) SimaPro, and GaBI are LCA software programs used often in North America. Product manufactures, engineers and LCA specialists are among those professionals who create the LCAs, and although current rating systems give a nod to LCAs, they do not specify how to perform one (Kosik, W. 2008).

LCAs of products and buildings are beginning to increase in sustainability design solutions in North America (though have been used in Europe as a process for decades) yet as LCA reports become more mainstream in accompanying products and/or buildings, they are not the holy grail of environmental assessment tools. There are a number of important issues in the interpretation of LCA results, and though not likely intentional, can lead to confusing or improper conclusions. Baumann & Tillman (2004) identify the most significant factors to identify and understand when examining an LCA, especially if being used as a comparison tool. These issues include a thorough understanding the functional unit, systems boundaries, and the assumptions and limitations of the study, and, finally, the impact assessment categories.

These whole product system analyses are important for the building industry to contemplate a material from the entire lifecycle, including assembly, installation, and maintenance and landfilling; often not top-of-mind for professionals who are also specifying a material primarily based on aesthetics and cost. However, LCA results are not typically used to communicate externally (Underwriters Laboratories Inc., 1 (2011) to the public, and even if distributed, are too lengthy and technical in format for summary. Some LCAs in the past have tried to aggregate impacts, making a value judgment about which impacts to prioritize (Atlee & Melton, 2014). Important to note, and often a point of contention as LCAs become more popular in the marketing of sustainable products, is that environmental LCAs look at environmental burdens only, not any social or economic issues, thus limiting the scope from sustainability tool to environmental only.

In the release of LEED 2009, LCAs were included for the first time as means toward points (BREEAM 2014 also includes points for products with LCAs). Projects can use an LCA for points in two credits; MRc1: Building Life-Cycle Impact Reduction and MRc2: Building Product Disclosure and Optimization: Environmental Product Declaration (EPD) (USGBC, 2015a). MRc1 offers up to three points in the use of an LCA, and just as the LCA reports themselves can be complex, so is the process for these credits. The project teams have to model both a base case (referred to as the "reference model") and a design case of their project and show that the design case is better. This credit option considers six impact categories: global warming, acidification, ozone-layer depletion, eutrophication, formation of ground-level ozone and depletion of non-renewable energy resources. To earn the three points, the building design has to be at least 10% better (lower-impact) than the reference case in the global warming category and two others, and it cannot be more than 5% worse than the reference case in any of the categories. The entire building life cycle is included in the analysis, including extraction and manufacturing of the materials, operation of the building, and disposal of the materials at the end of the building's life (Malin et al., 2012).

The second option to use an LCA for credits in LEED, in MRc2: Building Product Disclosure and Optimization: Environmental Product Declaration, allows projects to use a summary of an LCA, an EPD, for a maximum of two points (through two options). The full description of EPDs will follow in the next section, but are based on the results of an LCA, and used as condensed LCA format to identify the environmental attributes (either good or bad) or a product. For the MRc2 credit (option 1), the design must use at least 20 different permanently installed products sourced from at least five different manufacturers (CaGBC, 2016b), and then meet one of five disclosure criteria; products with an LCA must have a, "publicly available, critically reviewed life-cycle assessment, which confirms to ISO 14044 and has at least a cradle to gate scope valued as one quarter (1/4) of a product for the purposes of credit achievement calculation" (Elixir Environmental, n.d.). Though LCA appears in LEED v4, it is argued that data provided in an LCA is not sufficient to rely on for design decisions (Melton et al., 2014).

2.6. Environmental Product Declarations (EPD)

An Environmental Product Declaration (EPD) reports the results of a product's life cycle assessment (LCA) as well as other information relevant to a product's environmental profile, including information on a product's carbon footprint, and its potential impact on global warming, ozone depletion, acidification of land and water, eutrophication, photochemical ozone creation, and the depletion of abiotic resources. EPDs are categorized as a Type III eco-label as defined under ISO 14025 (ISO 14025 outlines in general terms how an EPD is derived from an LCA (Atlee & Melton, 2014)), and are meant to be brief, fact-based documents that provide specific information by category. With the latest release of LEED focusing on life-cycle and holistic approach to materials, EPDs have been included as optional point credits in the Material & Resources credits under Building Product Disclosure and Optimization—Environmental Product Declarations. In order for the project to achieve the one point available, the EPD must meet ISO 14025, 14040, 14044, and EN 15804 or ISO 21930 and have at least a cradle to gate scope (USGBC, 2015a).

An EPD report provides impact results for each category, rather than an aggregated impact overall "score", which requires the professional specifying materials to decide whether, for example, worse performance in aquatic toxicity is justified by better performance in global warming potential (Atlee & Melton, 2014). Additionally, with a standard EPD being anywhere from 15-25 pages, and without any required standard formatting, they are often too arduous and time-consuming to read, or even scan through by professionals looking for only the relevant information (Melton, P. 2014a).

An in attempt to assist architects, designers, project managers etc. in the understanding and using an EPD or LEED v4, BuildingGreen.com created the 'EPD Quick-Start Guide' (See Appendix), as it been documented that EPDs are still too technical and too long for many designers (Atlee & Melton, 2014). The five steps are: 1) Note validity and verification, 2) Identify the declared or functional unit, 3) Comprehend the system boundary, 4) Scan the impact assessments, 5) Dare to compare. This guide identifies the many barriers which exist in the EPDs themselves, and also in professionals implementing them for projects (for LEED v4 MRc credits or otherwise).

When an EPD has been completed, it must be submitted to an independent third-party for a thorough review and verification of the results presented and any additional information supplied (Underwriters Laboratories Inc., 1a (2011). Finally, the submission of the final document to an EPD program operator for registration and inclusion in the operator's published list of registered EPDs is the last step in the process of creating an ISO- certified EPD. UL Environment is responsible for the majority of EPDs that have been published to date, and also has the most extensive list of EPDs openly available in its Sustainable Products Database (Melton et al., 2014). Other organizations that can act in the program operator role include NSF International, ASTM International, and ICC Environmental Services (ICC-ES), however these organizations are not the ones actually completing the LCAs.

Since EPDs have not been used for a prolonged time in North America, yet can be included to obtain points for LEED v4 certified projects, the process of creating EPDs is still going through transition. Melton et. al. (2013) discuss this vague process in the article, *Finding Products for LEED v4- A Guide*,
"They (the program operators) just ensure that the studies follow the appropriate product category rules and that they've been translated properly into the EPD format. Because EPDs are relatively new in the U.S., the program operators have been busy sorting out the product category rules while trying to meet ISO's stipulation to avoid creating duplicate PCRs within a product category. When program operators attempt to produce the first U.S.-based EPDs in a category, they can either create a PCR from scratch—as ICC-ES has done for pressure-treated wood—or adapt one from Europe, which is UL Environment's preferred approach".

Although an EPD should be based strictly on the findings from a conducted LCA, there still lies some grey zones in the validity of an EPD, which some find conflictive, at best. LEED v4 gives an option for an EPD credit for products certified as preferable by programs with an LCA-based approach, however without standard approved programs, this option lacks in validity. Furthermore, some trade organizations are now becoming program operators for EPDs, which could be questionable as to whether this constitutes the independent third-party program operator as required by ISO. For example, the National Ready-Mixed Concrete Association (NRMCA) has become the program operator for concrete products (Melton, P. et al, 2013); evidently, the process of selected program operators can be problematic.

In LEED v4, EPD's are included for point potential in the Material & Resource category, under MRc2, Building Product Disclosure and Optimization—Environmental Product Declarations. Projects can receive points for simply specifying a product or material that has a supporting EPD with it (under the 'Disclosure' option), but in order to get points in LEED v4 for the 'Optimization' option, the product must demonstrate reductions in a minimum of three impact categories. And therein lies some of the issue with EPDs and LEED v4 points; the fact that a product has an EPD doesn't mean anything about the level of its environmental impacts (Atlee & Melton, 2014), but can, however, increase count toward LEED certification. Therefore, professionals with limited knowledge of the intricacies of EPDs may specify a material because it has an EPD, yet it could very well have high environmental impacts across all impact categories (primary energy, GWP, ozone depletion, acidification, eutrophication, photochemical ozone creation).

Furthermore, beyond being large documents, filled with complex data and terminology, and the inclusion of an EPD not indicating an actually environmentally preferable product, the lack of comparability in EPD reports in finding and using a preferred product, is likely an obstacle to architects and designers implementing more sustainable materials. As EPDs are based on LCA reports, there are a number of factors (many of which professionals are not likely not too familiar with), that can drastically change the impacts of a material, but that are difficult to compare from one EPD to another. In BuildingGreen's *EPD Quick-Start Guide*, it is suggested that a "rough" comparison could be done by ensuring that three factors are the same: the product category rule, the functional or declared unit, and the system boundary. However, based on empirical studies which indicate time to research as a major barrier to green design (authors), it is unlikely that architects and designers have the time to mine through the reports to see if, for example, the system boundaries are identical: both products' EPDs may include a cradle-to-grave approach, but one could exclude impacts from deforestation while the other could include material reclamation. A scan of the final impact assessments in an EPD may appear to be an easy and graphic way to evaluate which material is environmentally preferable, however there are far too many considerations behind those numbers for such comparison.

2.7. Green Material Databases

In the overwhelming marketplace of self-proclaimed sustainable materials and greenwashing, the challenge of finding products which actually are more environmentally preferable is a challenge. Along with each type of interior material comes single- and multi- attribute labels, material specific ecolabels and a variety of sustainable categories to which they may meet (i.e., air quality, sustainable material sourcing, recycled content, recyclability, etc. to name just a few); with so many considerations, and often a lack of knowledge as to which label or environmental impact trumps others, architects and designers are often at a loss as to whether a material is, in fact, an environmentally preferable selection.
Private research companies have found that there is a need create lists and databases to aid interior designers in the material selection process, with one of the first tools

created being product “red lists”, which inform of chemical hazards associated with a particular substance (Cargo, A. 2015). In the 2015 study, *An Evaluation of the use of Sustainable Material Databases within the Interior Design Profession*, author Alicia Cargo discusses that although they can inform of hazards, what they don’t offer alternative environmentally friendly (or friendlier) solutions.
In *Selecting Safer Building Products in Practice*, author Jennifer Atlee (2011) discussed the many challenges a building professional faces when trying to select “safer” materials. So although there are many green material databases to assist in this selection process, architects and designers are often still left in with question: are there safer (red-list chemical free) products that work, and are available, and are affordable? Is a product, free of a red-listed chemical, containing a lesser-known hazard?
Green material databases were created with the intention of assisting architects, interior designers, specifiers, project managers, etc. with the process of selecting materials that meet some minimum (and validated) environmental standard, from as many different manufactures as possible.
Red lists should be wielded with care, however. New or lesser- known substitutes for a red-listed chemical are not necessarily safer (Atlee, J. 2011).

2.8. Designer Pages (formally GreenSpec)

Designer Pages, formally the Green Spec database, Green Spec uses five high-level environmental performance criteria to determine which building products rack among the greenest 10% of all products in their categories (Cargo, A. 2015).

2.9. The Pharos Project

The Pharos project, created by the Healthy Building Network (HBN), is a materials evaluation system, database and building information site, offering an independent and comprehensive database for identifying health hazards associated with building products (Pharos Project, 2016). Further, its mandate is to also encourage transparency in a material ingredient disclosure from manufactures, pushing the industry further towards ingredient disclosure. Launched in 2009 (with Pharos v3 launched in October of 2015), Pharos offers three library databases to building professionals: the Building Product Library, Chemical and Material Library, and Certifications and Standards Library, with three general areas of concern, or attributes, addressed: Health and Pollution, Environment and Resources, Social and Community. The Pharos project and libraries seek to define a consumer-driven vision of what defines truly green building materials, and to create a method of evaluation which aligns with the principles of environmental health and justice (Rider et al., 2011). The library provides users a comprehensible and searchable list of hazards which appear in building materials: it compiles a wide spectrum of government hazard lists, making them accessible to anyone seeking to understand whether a chemical present in a product is of high concern (Atlee, 2011). Pharos also offers an important aspect often missing in the green product movement-transparency: Pharos provides a public and transparent alternative to proprietary lists such as Cradle to Cradle (Atlee, 2011). As of publishing, the Pharos Project has evaluated over 1,584 building products and components from 327 manufactures, leading to profiles of 38,282 chemicals and materials (Pharos Project, 2016). Similar to EPDs and LCAs, Pharos does not aggregate impacts of the materials and hazards, leaving it up to the user to determine how to value categories, or attributes, in comparing products (Atlee, 2011).

2.10. Transparency

Created by global design firm Perkins+Will, the Transparency database was created to fulfill a need to make known the hazardous chemicals that exist within a myriad of materials and products used in buildings (Cargo, A. 2015). Specifically, a senior designer who was working on a neonatal intensive care unit was challenged to find hazardous and toxic free material ingredients within the materials and finishes, for one of the most susceptible and fragile group of patients. The design team began creating an internal list of material ingredients with known health risks. Upon completion of the neonatal intensive care unit, Perkins+Will decided this knowledge was best shared, and thus the Transparency list was created.

2.11. Declare

The new Declare program under development by the International Living Future Institute (ILFI) will reference the HPD. The Declare label is designed to be a simple, attractive way for manufacturers to fully disclose the ingredients of their products (Atlee & Melton, 2014).

With the exception of undisclosed proprietary ingredients, a product can be listed in Declare regardless of how toxic its components may be. vets the ingredient list by comparing with industry standards, and it cross-checks each ingredient against two other lists—chemicals targeted by the U.S. Environmental Protection Agency's chemical action plan and those considered "of very high concern" in the European Union's REACH program. Known human carcinogens and several persistent, bioaccumulative toxic substances will be marked as chemicals of concern in the database and will show up in orange on the product's accompanying Declare label (Melton, P. 2014b). On April 4, 2016, the U.S. Green Building Council (USGBC) announced that the Living Future Institute's Declare label is now an approved pathway for Option 1 of the Building Product Optimization and Disclosure, Material Ingredients credit for LEED v4 (Living Future, 2015a).

The Red List bans 22 common ingredients (including any added formaldehyde, halogenated flame retardants, and phthalates). There are temporary exceptions for numerous Red List items due to current limitations in the materials economy (the v3.1 Materials Petal Handbook contains complete and up-to-date listings, as the Red List changes often). As of publishing, the Red List is as follows (i.e. a project trying to meet The Living Building Challenge certification cannot contain the following materials or chemicals):

Table A4: Red List Banned Materials and Chemicals

Red List Banned Materials and Chemicals	
Alkylphenols	Halogenated Flame Retardants (HFRs)
• Asbestos	Lead (added)
• Bisphenol A (BPA)	Mercury
• Cadmium	Polychlorinated Biphenyls (PCBs)
• Chlorinated Polyethylene and Chlorosulfonated Polyethylene	Perfluorinated Compounds (PFCs)
• Chlorobenzenes	Phthalates
Chlorofluorocarbons (CFCs) and Hydrochlorofluorocarbons (HCFCs)	Polyvinyl Chloride (PVC
Chloroprene (Neoprene)	Polyvinylidene Chloride (PVDC)
Chromium VI	Short Chain Chlorinated Parafans
Chlorinated Polyvinyl Chloride (CPVC)	Wood treatments containing Creosote, Arsenic or Pentachlorophenol
Formaldehyde (added)	Volatile Organic Compounds (VOCs) in wet-applied products

Appendix B- Current Green Systems & Certifications

The green building industry has grown exponentially in the last 15 years: in Canada, the number of LEED certified green buildings alone has gone from 1 in 2003 to 590 in 2013 (CaGBC, 2016c). And while the number of professionals who have green trainings and accreditations is not available, it may be assumed that the growth of certified buildings matches the growth of accredited professionals. This section provides an overview of the relevant green building rating systems (GBRS) within Canada.

1. LEED

The LEED (Leadership in Energy and Environmental Design) certification system, for both buildings and communities, was unveiled in 2000 by the USGBC (United States Green Building Council), and introduced into Canada in 2002 by the CaGBC (Canada Green Building Council), with the first LEED building being certified in 2003. The CaGBC owns the license to certify LEED buildings and communities, however individuals wanting to become a LEED accredited professional (LEED Green Associate, LEED AP or LEED Fellow), must take and pass the required exams administered by the USGBC. While LEED Green Associate is available to anyone with building experience, LEED AP qualifications can only be completed by individuals who a) have already completed the LEED Green Associate exam, and b) can demonstrate an advanced depth of knowledge in one of the five specialized areas of LEED Rating System. These areas for project certification, and AP titles, are:

- LEED AP Building Design + Construction (BD + C)
- LEED AP Homes
- LEED AP Interior Design +Construction (ID + C)
- LEED AP Neighbourhood Development (ND)
- LEED AP Operations + Maintenance (O+M)

Seven topics are included in LEED NC for a total assessment, namely Sustainable Sites, Water Efficiency, Energy and Atmosphere, Materials and Resources, Indoor Environ-mental Quality, Innovation in Design and Regional Priority. Projects are certified based on a total number of 110 points; 100 of those are “base” points, with six additional for Innovation in Design and another four Regional Priority points.
Project teams can register a project for certification at four levels:

- Certified (40-49 points)
- Silver (50-59)
- Gold (60-79)
- Platinum (80 +)

The LEED green building rating system acknowledges these varying priorities by, after a minimal number of prerequisites, basing the award (certified, silver, gold, platinum) solely on the total number of points achieved. This has led to criticisms that a LEED building, even a Platinum building, could conceivably be achieved without design solutions relating to energy or indoor air quality (IAQ) beyond the prerequisites (Atlee, J. 2011).

Since 2004, the CaGBC has certified over 2,600 LEED buildings in Canada and registered over 6,000, the second highest number in the world (CaGBC, 2016c). Table __ indicates the growth of LEED in Canada, showing the number of certified projects (across all four levels) since 2003. Of interesting note is the slight decline of certified projects from its peak in 2013 of 590 to 521 in 2015.

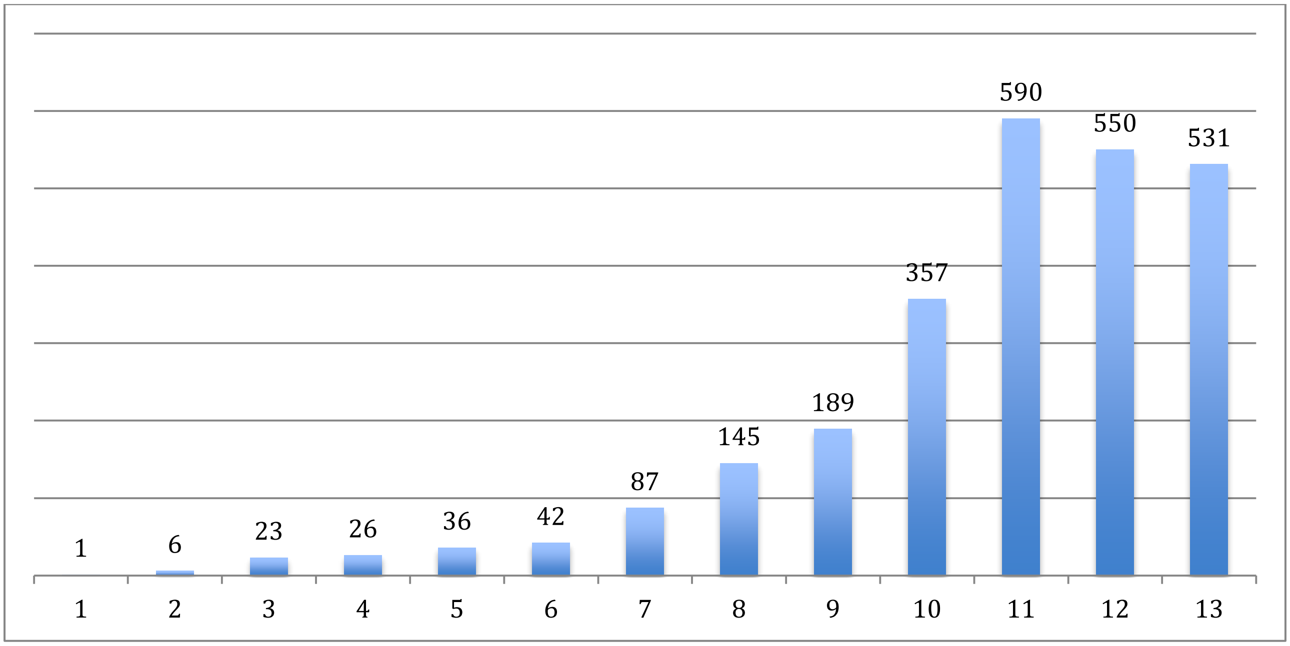

Figure B1: Certified LEED Buildings in Canada. (Number from Project Profiles- CaGBC, 2016a)

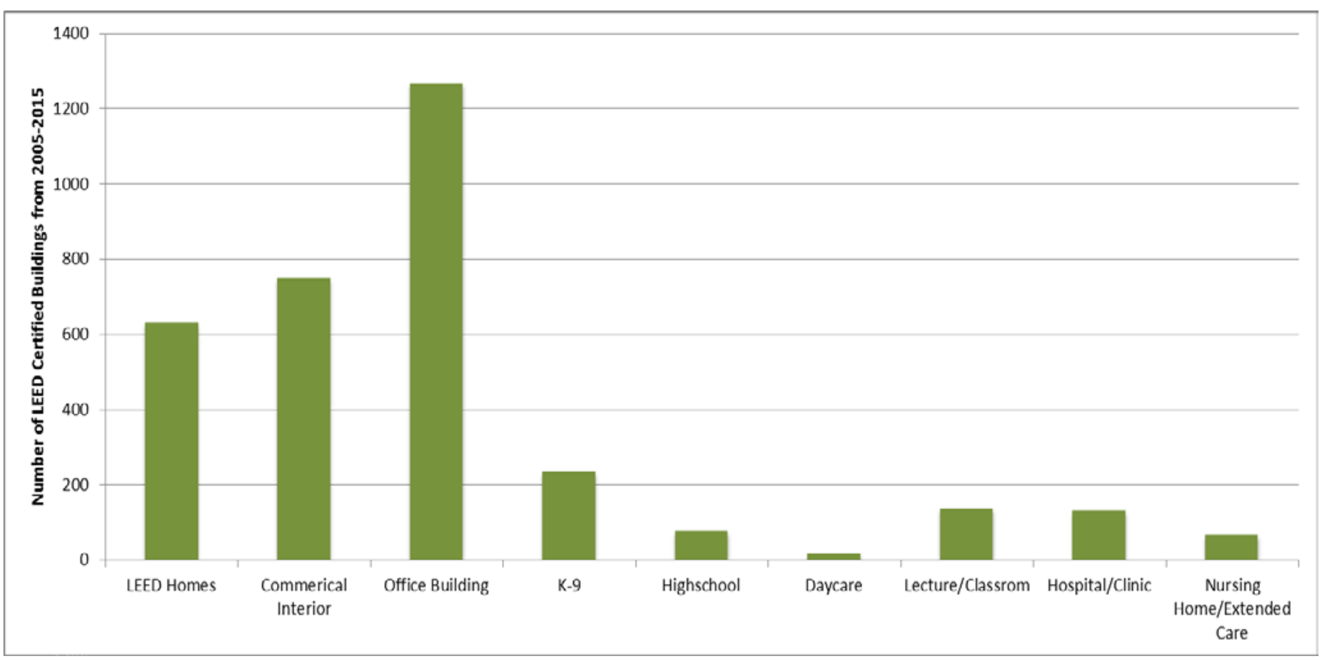

Figure B2: LEED Building Profiles in Canada (adapted from CaGBC website, CaGBC, 2016a).

On average, a LEED building consumes 25 to 30 percent less energy compared to conventional counterparts (Kats, 2003; Turner & Frankel, 2008). However, studies have since been published (Newsham et. al. (2009), Turner & Frankel, 2008) that identify some LEED commercial buildings which consume 25% greater energy than conventional buildings. In addition to signalling a building's performance qualities, the LEED certification also signals other qualities not directly related to building performance for tenants or owners. Besides signaling performance qualities, LEED certification also indicates other qualities not directly related to building performance for occupants. Certification enables occupants to attract higher quality employees (Eichholtz et al., 2010a). Further, Lanfranchi and Pekovic (2014) find that employees working for firms with green certification feel more useful and equitably recognized, and are more likely to work uncompensated overtime. Other performance advantages associated with different LEED credits include indoor environmental quality that makes the building a more desirable place to work and increases worker productivity (Cidell & Beata, 2009; Cole, 1998).

1.1. LEEDv4

In November of 2013, the USGBC released the latest version of LEED, version 4 (LEED v4), following three years of development. The latest edition takes a very different approach to its green building approach, prescribing to a more whole building life-cycle approach. Included in the changes of LEED v4 are a greater emphasis on performance (evidenced in water and energy credits), LCA and EPDs in the Materials category, and issues addresses integrative design, envelope commissioning and acoustics (CaGBC, 2016c). With many new credit options and requirements, the USGBC and CaGBC are allowing projects to remain being credited under the LEED 2009 system until October 31, 2016 (bumping it back from a June 2015 deadline).

In addition to the new and revised credits, LEED v4 specifically addresses using the LEED certification system in Canada, in the new Alternative Compliance Paths (ACPs), created by the CaGBC. Prior to LEED v4, most Canadian LEED buildings were based on LEED Canada rating systems (released in 2004). However, in an attempt to keep LEED standards a global rating system, these ACPs, "underscore LEED's regional and local applicability by recognizing leading Canadian local standards and practices in LEED" (UDGBC, 2016

The new LEEDv4 begins to apply a lifecycle approach to both the building and products, which is reflected in many of the new and revised credits. The new Materials and Resources (MR) credit category in LEED v4, with 14 points available, focuses on, "minimizing the embodied energy and other impacts associated with the extraction, processing, transport, maintenance, and disposal of building materials. The requirements are designed to support a life-cycle approach that improves performance and promotes resource efficiency" (USGBC.org, 2015a). There are total 13 points available within the MR credits. As mentioned in the introduction, the new LEED v4 credits aim at reducing waste from the built environment, and established a hierarchy of reduction, aligned to the EPAs strategies: source reduction, reuse, recycling, and waste to energy

(USGBC.org, 2015a). Another interesting change in LEED v4 is that it has combined two important credits: building and material reuse (MRc1 and MRc3 in LEED 2009) (Melton et al., 2014).

LEED v4 offers five project types for certification: Building Design and Construction (BD&C), Interior Design & Construction (ID&C), Building Operations and Maintenance (BO&M), Neighbourhood Development (ND) and Homes.

Table B1below summarizes the MRc in BD&C, as well as ID&C, the two most relevant in this study.

Table B1: LEED v4 BD&C and ID&C Material and Resources Credits

LEED v4 Building Design & Construction	Credits	LEED v4 Interior Design & Construction	Credits
Storage and Collection of Recyclables	Required	Storage and Collection of Recyclables	Required
Construction and Demolition Waste Management Planning	Required	Construction and Demolition Waste Management Planning	Required
Building Life-Cycle Impact Reduction	5	Interiors Life-Cycle Impact Reduction	4
Building Product Disclosure and Optimization - Environmental Product Declarations	2	Building Product Disclosure and Optimization - Environmental Product Declarations	2
Building Product Disclosure and Optimization - Sourcing of Raw Materials	2	Building Product Disclosure and Optimization - Sourcing of Raw Materials	2
Building Product Disclosure and Optimization - Material Ingredients	2	Building Product Disclosure and Optimization - Material Ingredients	2
		Long-Term Commitment	1

The complexities of LEED credits related to products are vast, and seem to become more so in each new version. It is important in this study to identify the many criteria products have the potential to gain points (or calculations toward a point), to establish the depth and also challenges to these categories.

Option 1 for each of these credits considers a number of products. The purpose is to encourage manufacturers to participate in disclosure and transparency (a new metric in LEED), and each credit has different weightings for a product depending on the stringency of the transparency program. Option 2 is calculated by cost and, for each credit, structure and enclosure materials may not constitute more than 30 percent of the total value of compliant building. Once that 30% cap is reached, the value of the structure and enclosure materials cannot count toward the cost of the compliant products, but their value must still be included in the total product costs (Baer, S. 2013).

Table B2. Overview of LEEDv4 Material & Resource Credits (summarized from USGBC Credit Category Overview: USGBC.org, 2015a).

LEED v4 MR Credit Title	Credit Overview	
	Option 1	Option 2
MRc1- Building Life-Cycle Impact Reduction	Combined two credits from LEED 2009 (MRc1 and MRc3): building and material reuse Credit can be awarded for onsite or off-site material reuse, this credit calculates the contribution of those materials as a percentage of building surface area	whole-building life-cycle assessment
MRc2- Building Product Disclosure and Optimization—Environmental Product Declarations	To earn one point for a label or declaration provided by a manufacturer to ensure that the product has met the appropriate requirements	One point can be earned for selection of products with an optimized environmental profile.
MRc3- Building Product Disclosure & Optimization—Sourcing of Raw Materials	addition of a point for product manufacturers reporting information regarding human and ecological impacts, specifically their extraction practices, land use practices, and other sourcing-related impacts Corporate Sustainability Reporting (CSR)	A second point for using products that optimize the extraction process, by limiting or eliminating extraction of new resources (using reused materials or using recycled content) or using best practices for extraction processes such as FSC-certified new wood products or biobased material meeting the SAN standard
	extended producer responsibility, or EPR: "product take-back," manufacturer has established measures to reclaim its products at the end of their useful life and to recycle them into the same product in a "closed loop"	
MRc4- Building Product Disclosure & Optimization—Material Ingredient Reporting	One point provides credit for products that disclose constituents through one of the reporting programs-	Provides incentive for manufacturers to go beyond awareness and disclosure of

	manufacturer inventory-publishing Chemical Abstract Service Registration Numbers (CASRN) for all ingredients in the product. Health Product Declaration (HPD must include all ingredients down to 0.1% (1,000 ppm) and full disclosure of health hazards from ingredients As of April 5, 2016, the USGBC included Declare, and a C2C Material Health Certificate as part of Option 1- disclosure.	product formulations and to begin eliminating potentially hazardous chemicals from their supply chains. Second point is available for products that demonstrate optimization through one of the referenced comparative assessment systems: REACH (Registration, Evaluation, Authorisation and Restriction of Chemical Substances) EU GreenScreen List Translator C2Cv3 Silver or v2 Gold certification full GreenScreen hazard assessment

MR incentives come up in three new two-part credits—all covering Building Product Disclosure and Optimization—which offer points for publishing environmental impacts (even if the impacts are heavy) and product ingredients (even if the ingredients are harmful) (Malin, B. et. al., 2014). Specifically, projects can earn up to 2 points in LEED-New Construction Credit 4, Building Disclosure and Optimization—Material Ingredients, using C2C certified products, whose chemical ingredients are inventoried using an accepted methodology and to select products verified to minimize the use and generation of harmful substances (USGBC, 2015a). Building Life-Cycle Impact Reduction for whole-building life-cycle assessment (LCA). This option allows new buildings to garner three points in a credit that also offers points for reusing existing buildings and/or salvaged materials (Malin, B. et. al., 2014).

The scope of all three Building Optimization and Disclosure credits includes permanently installed building products and excludes active mechanical, plumbing, electrical (MEP) and specialty equipment (however, inactive MEP materials, i.e. duck work, piping, can now be included); full disclosure and optimized performance, can contribute up to six points in the MR section (Baer, S. 2013).

MRc2- Building Product Disclosure and Optimization—Environmental Product Declarations, requires disclosure of the life-cycle impacts of products as conveyed by

EPDs. Option 2 of the EPD credit seeks to reward products that have been certified as preferable by programs with an LCA-based approach (Melton et. al, 20134).
The origin of materials is addressed in Credit 3 by requiring the disclosure of corporate social responsibility (CSR) criteria for the mining and extraction companies engaged in primary resource exploration and processing. The central three credits in the MR credit category for LEED BD+C and ID+C projects are all Building Product Disclosure and Optimization credits (Baer, S. 2013).

Building Product Disclosure and Optimization—Sourcing of Raw Materials creates new incentives to use biobased building products. But "biobased" might describe anything from undyed wool to highly processed corn- or soy-based plastics, and the impacts of many biobased materials can exceed those of the fossil-fuel materials they replace (Malin, B. et. al., 2014). Non-forestry materials, including biobased, would have to be certified to the Sustainable Agriculture Network (SAN) standard (similar to FSC in scope but instead covers crops). Finding LEED v4-compliant products should be easy in some areas and will be impossible in others (Melton et al., 2014).

2. BREEAM

Considered the oldest of the current green building ratings systems (GBRS), the Building Research Environmental Assessment Method (BREEAM) was launched in 1990 in the United Kingdom by the Building Research Establishment (BRE) with over 545,600 BREEAM certified developments across 77 countries (BREEAM,2016), primarily Europe. The BREEAM method is used to measure and rate buildings across 10 compliance categories: management, health and wellbeing, energy, transport, water, materials, waste, land use and ecology, and pollution. During the assessment process, each category is sub-divided into a range of issues, which promotes the use of new benchmarks, aims and targets, and certification levels are Pass, Good, Very Good, Excellent and Outstanding, represented by a star rating (1-star for Pass, 6-stars for Outstanding). Interior materials available for credits included in BREEAM (related to the scope of this study)are internal walls, doors, floor finishes, ceiling finish and other, "significant" finishes (BRE Global, 2014).

The BREEAM methodology was not relevant in North America until 2012, when, recognizing the need for stronger international standards, the USGBC announced that LEED will recognize credits from BREEAM, beginning with LEED for New Construction and the most recent International version of BREEAM (USGBC, 2012). Further, as of June 2016, it was announced the BREEAM USA would be launched, through a partnership by BRE and BuildingWise, a U.S.-based LEED certification consultancy, and will make the BREEAM In-Use standard available to commercial buildings of any size, age, and condition (BuildingGreen, 2016d). As of time of writing, BREEAM still remains most relevant in the UK, and so is only being discussed briefly, as the future of the system, and its' impacts on sustainable materials within North America, remains unclear. Therefore the BREEAM system is not expected to have any influence on the scope, or participants, of this study.

3. The Living Building Challenge (LBC)

A program created and maintained by of the International Living Future Institute, The Living Building Challenge (LBC) is a philosophy, advocacy tool, and certification program. What is now known as the Living Building Challenge began in the mid-1990s with a team of designers embarking upon the implementation of some of the most advanced sustainable design theories available in the design of The EpiCenter in Bozeman, Montana; successes, challenges, and environmental implications were documented through various matrixes, articles, and what would later become version 1.0 of the Living Building Challenge. In 2006, the Living Building Challenge was publically launched; Living Building Challenge version 1.0 was gifted to the Cascadia Green Building Council in August 2006, and three months later the Challenge was formally launched to the public, with the first project certified in 2010 (The Living Building Challenge 3.0, 2014). The International Living Future Institute was formed to provide ongoing oversight and updates to the LBC (Anonymous, 2013), with a mission to lead the transformation to a world that is socially just, culturally rich and ecologically restorative (The Living Building Challenge 3.0, 2014). Since its inception in 2006, two more versions of the Living Building Challenge have been released: v2.0 launched in November 2009 and v3.0 released in May 2014, which challenges designers to design ideal "green" buildings (Atlee, 2011). The LBC is a recognized program by the Canadian Green Building Council (CaGBC), offering courses and education on the system.

Implemented at all scales, from buildings to infrastructure, landscapes and neighbourhoods, the Living Building Challenge differentiates itself from other GBRS by advocating for net-zero use, net-zero water use and fully onsite waste processing over a minimum of 12-months of continuous occupancy (Ching & Shapiro, 2014). Quite diverse in the categories of built environment certifications, projects fall into four different "typologies": Renovation, Infrastructure + Landscape, Building, and Community, with seven performance areas in each: Site, Water, Energy, Health, Materials, Equity and Beauty. These seven performance areas are then divided into twenty Imperatives visually represented by the "petals" in their logo (CaGBC, 2016b).
And although certification requires meeting the 20 imperatives, some typologies require fewer than twenty Imperatives because the conditions are either not applicable or may compromise other critical needs: All twenty Imperatives are required for Buildings, fifteen for Renovations and seventeen for Landscape and Infrastructure projects (Living Future, 2015b). Unlike other GBRS, including LEED, certification is based on actual (not modeled) performance: A project must be operational for 12 consecutive months before the building can apply for any level of certification.

Projects can achieve three levels of certification: Living Building (or Full) Certification, Petal Certification or Net Zero Energy Building Certification, and both Living Building and Petal certifications have three steps to certification: Registration, Documentation + Operation and Audit + Certification. Living Building Certification is the most difficult of the three, requiring projects to demonstrate that the built environment can help restore the natural environment, rather than take from it. Recognizing the difficulty in achievement, Petal Certification was introduced to acknowledge the achievement in attaining some, but not all, of the Petal Imperatives; three or more Petals must be achieved for certification, including at least one of the following: Water, Energy or Materials, as well as both 01: Limits to Growth and Imperative 20: Inspiration and Education. Net Zero Energy certification recognizes building projects that achieve the Energy Petal, along with a subset of Imperatives within the Place and Beauty Petal) (Living Future, 2015b)). As of publishing, there are 23 buildings with Net Zero Energy certification in the U.S. (none in Canada), 10 buildings in Canada with Petal certification (25 in the U.S.), and nine with Full Living Building certification in Canada, with 92 in the U.S. (Living Future, 2015c).

3.1. Materials in LBC

The intent of the Materials Petal is to help create a materials economy that is non-toxic, ecologically restorative, transparent, and socially equitable, with the Imperatives within the Materials Petal section aim to remove the worst known offending materials and practices (The Living Building Challenge 3.0, 2014). Within the Materials category, there are five imperatives: Red List, Embodied Carbon Footprint, Responsible Industry, Living Economy Sourcing, and Net Positive Waste, with the last two imperatives being new titles in the v3.0 release (Atlee, n.d.).

Table B3: Overview of Material credits in The Living Building Challenge

Petal Credit	Overview
Embodied Carbon Footprint	One-time carbon offset equal to the calculated total carbon footprint of the project (either to Living Future Carbon Exchange or an approved carbon offset provider)
Responsible Industry	Project must advocate for the creation and adoption of third-party certified standards for sustainable resource extraction and fair labour practices. All wood certified to FSC 100% labelling standards All projects must use one Declare product for every 500 square meters of gross building area; must send Declare product information to 10 manufactures not using Declare.
Living Economy Sourcing	Incorporate place-based solutions and contribute to the expansion of a regional economy rooted in sustainable practices, products and services: - min. 20% materials construction budget from 500km of construction site - additional 30% materials construction budget from 1000km of construction site or closer - additional 25% materials construction budget from 5000km of construction site - 25% from any location *Consultants must come from within 2500km of project location
Net Positive Waste	Strive to reduce or eliminate the production of waste during design, construction, operation, and end of life. All Projects must feature at least one salvaged material per 500 square meters of gross building area or be an adaptive reuse of

	an existing structure. Create a 'Material Conservation Management Plan' Dedicated infrastructure for the collection of recyclables and compostable food scraps. During construction, must divert wasted materials to the following levels: Metal- 99% Paper & Cardboard- 99% Soil & Biomass- 100% Rigid Foam, Carpet & Insulation- 95% All others- 90%

The latest version of Living Building Challenge also integrates the new JUST™ label, a voluntary disclosure program and tool on social justice, or a "nutrition label" for socially just and equitable organizations, similar to the Declare program, both created and managed by The International Living Future Institute's™.
Issues present themselves in the LBC materials challenge, as in all other GBRS. Atlee (2011) found that many project teams working toward the LBC have found the red-list among the most difficult and time-consuming aspects of the Challenge, particularly in conjunction with another Materials Imperative, "Appropriate Sourcing," that steers design teams toward regionally sourced materials.
In Imperative 10- Red List, documents demonstrating genuine effort to exclude Red List products may be accepted if a product includes a material or chemical on the list.

4. Green Globes

The first web-based environmental assessment, education and rating system, Green Globes was introduced in 2000, with revisions in 2004 and 2014 (Wu et al., 2016), and based primarily on ASHRAE standards and on the ANSI/GBI 01-2010: Green Building Assessment Protocol for Commercial Buildings (Green Globes, n.d.). Green Globes Design is offered as both a guide to integrating green design principles and an assessment tool to certify green building (Green Globes, 2014). Green Globes originated from the BREEAM system: based on the 1996 CSA publication of BREEAM Canada, Green Globes for Existing Buildings was developed in 2000 as the first online system; the Existing Buildings module is at the heart of BOMA Canada's national environmental program (Green Globes, 2014). Green Globes is now developed by the Green Building Initiative (GBI). Green Globes is promoted as an affordable and streamlined alternative to the LEED system (Ching & Shapiro, 2014). As of publishing, there were 143 certified buildings meeting the Green Globes in Canada (1064 across the United States)with the Canadian Federal Government is using this system in its whole real estate portfolio (Wu et al., 2016).

In 2013, Green Globes launched the updated Design for New Construction V2, which is largely based on the ANSI/GBI 01-2010 standard (Green Globes, 2014). Similar to LEED v4, the release of v2 also saw the inclusions of life- cycle assessments and environmental product declarations (EPDs), as well as a new "Innovation Criteria" category. This criterion focuses on the positive contribution of a building rather than just the reduction of its environmental impact, and is similar to that of the Living Building Challenge philosophy (Green Globes, 2014).

Green Globes certification levels are based on percentage numbers of criteria completed and certified using numbers of “globes”: 1 Green Globe (25-39%), 2 Green Globes (40%-54%), 3 Green Globes (55-69%), 4 Green Globes (70-84%), 5 Green Globes (more than 85%). The program is questionnaire-based survey and consists of approximately 400 questions of the “yes/no/na” type, and upon completion a printable report is automatically generated that provides an eco-rating and scores for a building (Green Globes, 2014). Of interesting note is that the Green Globes system offers the /not applicable” option for projects, recognizing that not all criteria are applicable to all projects (based on building scope, function, location, etc.). When completing the online assessment rating tool, any answers with “n/a” are removed from the survey score completely, so as not penalizing projects for criteria points which cannot be applied. There are a total of 1,000 points available in the Green Globes rating certification systems (New Construction, Existing Buildings and Sustainable Interiors), and the rating is given based on the percentage of applicable points that a project can obtain (Wu et al., 2016). There are seven environmental assessment areas within the New Construction category: Project Management (50 points), Site, (115 points), Energy (390 points), Water (110 points), Materials & Resources (125 points), Emissions (50 points), and Indoor Environment (160 points).

4.1. Material & Resources in Green Globes

The Material & Resource category of the Green Globes system account for a maximum of 125 of the 1000 total point available (therefore representing 12.5% of the system). There are 11 sub-assessment areas available for points within the Material & Resources category; however four of those are dedicated to the building envelope. Table B4 provides a breakdown and summary of the point available for the seven areas related to interior materials.

Table B4: Overview of Material & Resource point allocations in Green Globes

Credit	Point Value	Objective	Actions
Building Assembly (Core and Shell including the Envelope)	32	Increase demand for building products that incorporate recycled content materials…as well as those that are extracted and manufactured within the region.	Athena Impact Estimator for Buildings (Version 4.2 or later) to evaluate a minimum of two building assemblies (core and shell, including envelope) which will result in a selection that provides the least environmental impact.
Interior Fit-Outs(including Finishes and	10	Increase demand for fit-up products that incorporate recycled content	Indicate the percentage of the interior fit-out materials and products (including

Furnishings)		materials…as well as those that are extracted and manufactured within the region.	finishes and furnishings) selected (based upon cost) that have environmental product declarations (EPDs) or other third-party certified life cycle product assessments.
Re-Use of Existing Structures	24	Extend the lifecycle of the existing building stock, conserve resources, retain cultural resources, reduce waste and reduce the environmental impacts of new buildings	(6 points) Indicate the percentage of the façade from an existing building retained and incorporated in the new design. (5 points) Indicate the percentage of the structural systems from an existing building retained and incorporated in the new design. (13 points) Indicate the percentage of the existing non-structural elements reused within the renovation project
Waste	8	Redirect recyclable recovered resources back to the manufacturing process and reusable materials to appropriate sites; and facilitate the reduction of waste generated by building occupants that is disposed of in landfill	(5 points) Provide a Construction and Demolition Waste Management Plan with waste diversion targets, which identifies the materials that will be diverted (1 point) Reuse existing on-site materials for site development or landscaping (e.g. crushing concrete for aggregate base or drain rock, shredding vegetative materials for mulch, etc.) (2 points) Address operations-related recycling programs through the development of waste handling and storage facilities
Building Service Life Plan	7	Establish realistic expectations in regard to quantities of waste the building will likely produce over its lifetime	Prepare a preliminary Building Service Life Plan that includes the expected service life estimates for the

			building, structural systems, mechanical, electrical, plumbing, and energy generation systems
Resource Conservation	6	Extend the lifecycle of new buildings building stocks, and facilitate the future deployment of material resources in an efficient and sustainable manner	(3 points) Specify the use of prefabricated, preassembled, and/or modular products. The building design should use materials efficiently and/or minimize the use of raw materials as compared with typical construction practices (1 point) Incorporate assemblies that perform multiple functions (2 points) Facilitate future deconstruction, demounting and disassembly and re-configuration
Resource Innovation	10	Innovative solutions for carbon neutral buildings	Account for the total footprint of embodied carbon from the buildings' construction through a one-time carbon offset tied to the project LCA assessment

5. Passive House

Passive House, derived from the European *Passivhaus* standard, strives to maximize a building's energy efficiency while decreasing its ecological footprint, based on rigour and science in the design of a building. Passivhaus began in 1988 in response to the legal requirement in the mid-1980s that all new buildings meet a low-energy standard in Sweden and Denmark, with the first building, a Passivhaus with four units, Darmstadt-Kranichstein, being built to Passivhaus standards in Germany in 1990 (Passipedia, n.d.). An international standard system, Passive House is operated in Canada by the Canadian Passive House Institute (CanPHI), a registered non-profit educational organization providing training, support and certification for those looking to build to the Passive House standard, or building professionals wanting to become a Certified Passive House Designer (CPHD) (CanPHI, 2016). To date, there are 3559 certified Passive House buildings, with 23 in Canada and 73 in the U.S. (Passive House Database, 2014).
Two of the largest considerations in the Passive House standard are excellent thermal performance and airtightness, while using a heat-recovery ventilation system to supply fresh air for indoor quality (Ching & Shapiro, 20 14); the entire concept of buildings being airtight is a contentious issue in sustainable design, beginning with the aforementioned

AIA design in the 1970's of airtight building, leading to SBS).

The Passive House focus on energy performance and thermal performance, projecting a 80-90% energy performance savings compared to conventional Canadian construction (CanPHI, 2015), and the building standard relies on seven passive design fundamentals: Pre-planning, Efficient Building Shape, Solar Exposure, Super Insulation, Advanced Windows, Airtightness, Ventilation with Heat Recovery, Ventilation Air Pre-heating, and Thermal Bridge-Free Construction. Unlike other GRBS, Passive House does not address materials and resources, building structure choices or finishes, so although relevant to the green building movement in Canada, not to this scope of this study.

Appendix C- Research Documentation

1.1- Survey Email Introduction- Architects

UNIVERSITY OF WATERLOO

You have been invited to participate in a research study conducted by Leah Scully Lasani, a Master's student in the School of Environment, Enterprise and Development (SEED) at the University of Waterloo in Ontario, Canada, under the supervision of Dr. Geoffrey Lewis and Dr. Jennifer Lynes. Your contact information has been attained through the publically accessible architects' directory on the OAA website.

The purpose of this research project is to explore the current state of environmentally preferred interior materials in the built environment within Ontario, though the lens of eco-labels and building certification systems. This study will also address the challenges to, and opportunities for, greater adaption of green interior materials.

Should you choose to volunteer your time, you will be asked to complete an anonymous online survey, which will take approx. 10 minutes to complete. This project has been reviewed and received ethics clearance through a University of Waterloo Research Ethics Committee.

If you would like to complete the survey, please click on the link below.

{Link to survey here}

Thank you for your time,
Leah Scully Lasani

1.2- Survey Email Introduction- Interior Designers

UNIVERSITY OF WATERLOO

You have been invited to participate in a research study conducted by Leah Scully Lasani, a Master's student in the School of Environment, Enterprise and Development (SEED) at the University of Waterloo in Ontario, Canada, under the supervision of Dr. Geoffrey Lewis and Dr. Jennifer Lynes. Your contact information has been attained through the publically published IDC 2014/2015 Member Directory.

The purpose of this research project is to explore the current state of environmentally preferred interior materials in the built environment within Ontario, though the lens of eco-labels and building certification systems. This study will also address the challenges to, and opportunities for, greater adaption of green interior materials.

Should you choose to volunteer your time, you will be asked to complete an anonymous online survey, which will take approx. 10 minutes to complete. This project has been reviewed and received ethics clearance through a University of Waterloo Research Ethics Committee.

If you would like to complete the survey, please click on the link below.

{Link to survey here}

Thank you for your time,
Leah Scully Lasani

1.3- Survey Information Letter- Architects

UNIVERSITY OF WATERLOO

You have been invited to participate in a research study conducted by Leah Scully Lasani, a Master's student in the School of Environment, Enterprise and Development (SEED) at the University of Waterloo in Ontario, Canada, under the supervision of Dr. Geoffrey Lewis and Dr. Jennifer Lynes. Your contact information has been attained through the publically accessible architects' directory on the OAA website.

The purpose of this research project is to explore the current state of environmentally preferred interior materials in the built environment within Ontario, though the lens of eco-labels and building certification systems. This study will also address the challenges to, and opportunities for, greater adaption of green interior materials.

Should you choose to volunteer your time, you will be asked to complete an anonymous online survey, which will take approx. 10 minutes to complete. Survey questions will focus on the architect's experience, interest and barriers to the specification of environmentally preferred interior materials. Participation of this study is voluntary and you may decline to answer any questions or withdraw from the survey at any point. Because this is an anonymous survey the researchers have no way of identifying you or getting in touch with you should you choose to tell us something about yourself or your life experiences.

The researcher guarantees that the results from the survey will be kept confidential. When information is transmitted over the internet privacy cannot be guaranteed. University of Waterloo practices are to turn off functions that collect machine identifiers such as IP addresses. The host of the system collecting the data, FluidSurveys, may collect this information without our knowledge and make this accessible to us. We will not use or save this information without your consent. If you prefer not to submit your survey responses through this host, please contact one of the researchers so you can participate using an alternative method such as through an e-mail or paper-based questionnaire. The alternate method may decrease anonymity but confidentiality will be maintained.

This survey is anonymous in that we do not ask for your name or any identifying information. Once you have submitted your responses it is not possible to withdraw your consent to participate as we have no way of knowing which responses are yours. We will keep our study records for a minimum of **seven** years. All records are destroyed according to University of Waterloo policy. There are no known or anticipated risks from being a participant in this survey.

This project has been reviewed and received ethics clearance through a University of Waterloo Research Ethics Committee. However, the final decision about participation is yours. Participants who have concerns or questions about their involvement in the project may contact Dr. Maureen Nummelin, the Chief Ethics Officer at 519-888-4567, Ext. 36005 or Maureen.nummelin@uwaterloo.ca."

If you would like to participate in this study, please click on the "survey" link within the email. Should you have any questions related to this survey or study, or would like a copy of the study results, please contact researcher Leah Scully Lasani at lascully@uwaterloo.ca, Dr. Geoffrey Lewis at g4lewis@uwaterloo.ca or Dr. Jennifer Lynes, jklynes@uwaterloo.ca.

With full knowledge of the abovementioned, I agree to participate in this study (by completing and returning the online survey, you are not waving your legal rights or releasing the investigators or involved institution from their legal and professional responsibilities) :

- [ ] "I agree to participate in this study."
- [ ] "I do not wish to participate in this study”

1.4- Survey Information Letter- Interior Designers

You have been invited to participate in a research study conducted by Leah Scully Lasani, a Master's student in the School of Environment, Enterprise and Development (SEED) at the University of Waterloo in Ontario, Canada, under the supervision of Dr. Geoffrey Lewis and Dr. Jennifer Lynes. Your contact information has been attained through the publically published IDC 2014/2015 Member Directory.

The purpose of this research project is to explore the current state of environmentally preferred interior materials in the built environment within Ontario, through the lens of eco-labels and building certification systems. This study will also address the challenges to, and opportunities for, greater adaption of green interior materials.

Should you choose to volunteer your time, you will be asked to complete an anonymous online survey, which will take approx.. 10 minutes to complete. Survey questions will focus on the interior designer's experience, interest and barriers to the specification of environmentally preferred interior materials. Participation of this study is voluntary and you may decline to answer any questions or withdraw from the survey at any point. Because this is an anonymous survey the researchers have no way of identifying you or getting in touch with you should you choose to tell us something about yourself or your life experiences.

The researcher guarantees that the results from the survey will be kept confidential. When information is transmitted over the internet privacy cannot be guaranteed. University of Waterloo practices are to turn off functions that collect machine identifiers such as IP addresses. The host of the system collecting the data, FluidSurveys, may collect this information without our knowledge and make this accessible to us. We will not use or save this information without your consent. If you prefer not to submit your survey responses through this host, please contact one of the researchers so you can participate using an alternative method such as through an e-mail or paper-based questionnaire. The alternate method may decrease anonymity but confidentiality will be maintained.

This survey is anonymous in that we do not ask for your name or any identifying information. Once you have submitted your responses it is not possible to withdraw your consent to participate as we have no way of knowing which responses are yours. We will keep our study records for a minimum of **seven** years. All records are destroyed according to University of Waterloo policy. There are no known or anticipated risks from being a participant in this survey.

This project has been reviewed and received ethics clearance through a University of Waterloo Research Ethics Committee. However, the final decision about participation is yours. Participants who have concerns or questions about their involvement in the project may contact Dr. Maureen Nummelin, the Chief Ethics Officer at 519-888-4567, Ext. 36005 or Maureen.nummelin@uwaterloo.ca."

If you would like to participate in this study, please click on the "survey" link within the email. Should you have any questions related to this survey or study, or would like a copy of the study results, please contact researcher Leah Scully Lasani at lascully@uwaterloo.ca, Dr. Geoffrey Lewis at g4lewis@uwaterloo.ca or Dr. Jennifer Lynes, jklynes@uwaterloo.ca.

With full knowledge of the abovementioned, I agree to participate in this study (by completing and returning the online survey, you are not waving your legal rights or releasing the investigators or involved institution from their legal and professional responsibilities):

☐ "I agree to participate in this study."

☐ "I do not wish to participate in this study”

1.5- Web-based Survey- Architects & Interior Designers

1. Please indicate the size of design firm where you are currently employed (number of full-time employees):

2. What category of the built environment do you specialize in?
    - Commercial
    - Healthcare
    - Educational
    - Hospitality
    - Residential
    - Other, please specify:

3. How many years' experience do you have working as a licensed architect/registered interior designer:
    - 0-5 years
    - 5-15 years
    - 15-25 years
    - 25+ years

4. Do you have any green building/ sustainable design trainings or designations:
    - No
    - Yes- please specify:

5. Of the total number of projects you worked on in the last two years, what percentage have been certified sustainable or green:
    - None
    - Less than 25%
    - 25% to less than 50%
    - 50% to less than 75%
    - 75% to 100%

6. Of the total number of interior materials you specified over the last two years, what percentage were certified environmentally preferable or green?
    - None
    - Less than 25%
    - 25% to less than 50%
    - 50% to less than 75%
    - 75% to 100%

7. Of your projects over the last two years in which environmentally responsible design (ERD) was/is a significant factor in the decision making process, how often did this ERD mandate come as a project requirement from the client?
    - Less than 25%
    - 25% to less than 50%
    - 50% to less than 75%
    - 75% to 100%

8. What is your primary motivator in specifying environmentally preferred interior materials:
    - Required to meet project certification requirements (i.e., LEED)

- Request/mandate from client
- Mission of firm
- Personal values
- Have not undertaken sustainable design projects
- Other, please describe:

9. When specifying environmentally preferred materials, what resources do you use to make decisions:
    - Materials library (within firm)
    - In-firm specifier
    - Manufacturer's literature (online or print)
    - Online green materials eco-database (Please list all that you use:)
    - Eco-label/certification organization (Please list all that you use:)

10. What label and/or supporting documentation is the most important to you when specifying an environmentally preferable material:
    - Green building rating system credit potential (please identify which system:)
    - EPD (Environmental Product Declaration)
    - LCA Study/Report (Life Cycle Assessment)
    - Material ingredients
    - Eco-label/environmental product certification
    - Other, please specify:

11. Which eco-label(s) or environmental product certification(s) do you most often include in interior material product specifications?
    -

12. Why is the aforementioned eco-label(s) or environmental product certification system(s) the most often utilized when specifying environmentally preferred interior materials (please rank the three most relevant from 1 to 3, with 1 being most relevant):
    - Number of products to choose from
    - Personal understanding of certification process
    - Required for project mandate (i.e., LEED)
    - Aesthetic attributes
    - Performance/durability
    - Marketing or visibility of manufacturer or product
    - Other, please specify:

13. When an eco-label or environmental product certification is not available for an interior material, what are the most important factors to you in selecting an environmentally preferred product? Please rank in order from 1 to 7 (with 1 being the most important)
    - Regional material(s)
    - Rapidly renewable material
    - Manufacturing process
    - Manufacturing location
    - Material ingredient disclosure
    - Durability/performance/life-cycle
    - End-of-life options (waste)

- Other (please specify:)

14. In your *professional* opinion, please rank the importance of the environmental factors below when selecting materials (please rank in order from 1 to 7; with 1 being the most important, and 7 being the least):
    - Rapidly renewable material
    - Regional material/transportation impacts
    - Recycled Content/ Recyclability
    - Indoor Air Quality/ Toxicity
    - Embodied Energy
    - Life-cycle (including end-of-life)
    - Other, please specify:

15. When a client requests environmentally preferred materials, how do they rank the environmental factors below (please rank in order from 1 to 7, with 1 being the most important and 7 being the least):
    - Rapidly renewable material
    - Regional material/transportation impacts
    - Recycled Content/ Recyclability
    - Indoor Air Quality/ Toxicity
    - Embodied Energy
    - Life-cycle (including end-of-life)
    - Other, please specify:

16. Please rank the importance of material ingredient disclosure (ingredient transparency) to you when specifying an interior material:
    - Very important; all material ingredients must be disclosed
    - Somewhat important; ingredient disclosure would help in selection process
    - Not very important; other environmental factors trump ingredient transparency
    - Materials are not selected based on ingredient disclosure

17. Are there interior material ingredient(s) that you most often avoid due to adverse environmental impacts?
    - No
    - Yes (please list)

18. Do you have experience in working with, and specifying materials for, LEED v4 Material & Resources credits:
    - Yes
    - No (skip to Q20)

19. Which of the available LEED v4 Materials and Resources credits are most commonly utilized on your current projects (or are referenced if using LEED v4 as a template for sustainable building systems) – select all that apply:
    - Building life-cycle impact reduction (MRc1)
    - Building product disclosure and optimization - environmental product declarations (MRc2)
    - Building product disclosure and optimization - sourcing of raw materials (MRc3)

- Building product disclosure and optimization - material ingredients (MRc4)

20. Do you have experience in working with, and specifying materials using, the Cradle2Cradle (C2C) product certification system:
    - Yes
    - No (skip to Q22)

21. Do you experience barriers in specifying products with C2C certification?
    - Yes (please explain:)
    - No

22. Do you have experience in working with, and specifying interior materials with EPDs (environmental product declarations):
    - Yes
    - No (skip to Q25)

23. Do you experience barriers in specifying products with EPDs?
    - Yes (please explain:)
    - No

24. Does the availability of an EPD assist in selecting an environmentally preferred interior material?
    - Yes (please explain:)
    - No

25. Do you have experience in working with, and specifying interior materials with LCAs (life-cycle assessments):
    - Yes
    - No (skip to Q28)

26. Do you experience barriers in specifying products with LCA reports?
    - Yes (please explain:)
    - No

27. Does the availability of an LCA report assist in selecting an environmentally preferred interior material?
    - Yes (please explain:)
    - No

28. What do you feel are the biggest barriers to specifying environmentally preferred interior materials (select all that apply):
    - Lack of product selection for environmentally preferred interior materials
    - Lack of information on benefits
    - Unclear of product certification processes
    - No common or clear product label(s) or standard(s)
    - Not required to meet project/client requirements
    - Not enough time to conduct research to make decisions
    - Other, please describe:

Appendix D- Survey List Results

Table D1:Other environmental factors when selecting materials, listed in Question 14:

“Other” responses by architects:	“Other” responses included by interior designers:
o light pollution, heat island o Cost o Quality/Workmanship o Durability, longevity of material, suitable material for the particular application. o Reusability o Reusability of durable items with high embodied energy o Which country may be impacted by the material selection o Volume or quantity - almost never a factor in LEED certification. I.e. 100 tons of concrete better than 500...	o Cost o Demonstrated reduced environmental impacts o Durability o contributions to regeneration o Limited use of the oil industry o Using materials to minimize demolition and disposals as much as possible. o There is also environmental impact to the demolition process when dealing with interiors and how removal of material impacts air quality both inside and out. o Installation method o Resistance to sunlight exposure & cold. o Water consumption during the manufacturing process

Table D2: Other responses listed in Question 15

"Other" responses by architects:	**"Other" responses by interior designers:**
o *cost* o *Cost* o *Cost* o *Cost* o *consultant's advice* o *Cost* o *Cost* o *COST, number 1.* o *Cost of Environmentally Preferred over Standard* o *To be honest, clients rarely care.* o *Look* o *they do not rank factors, the culture is missing* o *Reusability* o *Typically cost is the main motivating factor in all decisions, not the environment.* o *Cost* o *cost!*	o *Frankly, no clients ask for environmentally friendly materials. It is a little shocking.* o *Disposal* o *contribution to LEED* o *Quite often the client doesn't go further than what has been discussed above other than how to get rid of the demolition debris.* o *cost* o *price* o *most clients have little awareness of much other than recycling and IAQ* o *Installation methods and adhesion materials* o *LEED credits* o *durability to sunlight* o *Water conservation and consumption during the manufacturing process*

Table D3: Barriers to C2C utilization, listed in Question 21

Barriers experienced by architects	Barriers experienced by interior designers
o there are very few and higher cost o Limited products, needs more database and products on board with mission o Market availability o Cost o experience has been limited to furnishings not always available for products	o Sometimes more expensive - too expensive for the client budget o How much is the product C2C o There are too many rating systems out there with conflicting requirements o disposal of said materials is limited (i.e. ceramic tiles can be C2C certified, however once installed it is very difficult to recycle these materials because of the adhesives) o Not a very common designation yet at least here in Canada o finishes o There are no guarantees that C2C gets the material back into the product manufacturing loop, though with some large volume materials like commercial carpet we feel more confident o More product choice required

Table D4. Barriers to EPD utilization, listed in Question 23

Barriers experienced by architects	**Barriers experienced by interior designers**
o Need to understand what the ingredients mean to human and environmental health o Many product manufacturers are not honest tine their disclosures o New system. Not all manufacturers have them. o obtaining information, relative cost, performance o Currently working on 4 LEED V4 projects o cost o Costs sometimes because there are few manufacturers who supply EPDs and they are undercut by cheaper products. Budget trumps it in public projects if the Owner group not committed to the ideal o not all manufacturers have EPDs for their products o Manufacturers often are not aware themselves, or are not aware of post-processing o Not widely adopted in industry. Smaller players locked out.	o Not all Manufacturer's present the facts appropriately, chemicals are not differentiated by format i.e. liquid, solid, gas which matters o Some limitations in the quantity of products available information o Manufacturers not supplying information readily o We look for these on occasion when available - comparisons between competing products are nearly impossible due to the lack of consistency in manufacturers' adoption of EPDs

Table D5: Barriers to LCA utilizations, listed in Question 26

Barriers experienced by architects	Barriers experienced by interior designers
o Clients that only care about first cost and not lowest life cycle costs (either developers or money comes from different departments) o Few manufacturers have this data available o Client experience and knowledge with this o Encounter resistance sometimes because upfront capital costs might be higher than other options o information availability, costs o lack of products available with LCA's	o I'm only vaguely familiar, not sure what I need to look for. o Data used to create them is not transparent o Some limitations in product availability o manufacturers disclosure o not enough research for some products o Too few available LCAs and too little time to be practical. o not sure if end user will recycle or dispose as intended

Table D6: Biggest barriers to overall green material specification, listed in Question 28

Architects:	**Interior Designers:**
Cost *Used than and no need for approvals* *Mfr.'s inability to substantiate claims* *LEED and labelling bypass independent evaluation, science add bias* *Cost Premiums* *above selections mostly from client and/or contractor point of view as to the importance* *Lack of Support through third party project managers, misinformation and common misunderstandings* *missing culture* *fire rating* *Cost* *Cost prohibitive* *cost* *BUILDING CODE is the major barrier to good sustainable design*	*Cost to client for certification. I do specify preferred materials* *Client usually doesn't have the budget to allow for us to spend the time to be mindful of LEED points.* *cost* *Not enough budget.... ever.* *Lack of accurate information. Too much green washing* *suppliers are uninformed of the products properties/certification process/environmental aspects* *Lack of list of product ingredients even if certified.* *client lack of interest* *I need more education (CEUs) in this area to feel more competent* *biggest is cost* *no known common database to find all environmentally preferred interior materials- so much legwork involved in finding them* *Client not interested* *Cost* *time is short; pushing back against greenwash is exhausting; sales reps often have no clue what their product certifications and the manufacturers' claims actually mean; different certifications will be used by various competing products with similar claims; the basic science needed to effectively evaluate environmental claims is not well understood by colleagues, sales reps and clients* *not sure if end user will follow disposal recommendations by mfg.* *cost* *cost* *Similar products have different certifications: hard to compare.* *rely on wholesalers & industry shows to see/get knowledge of new products* *Cost* *not enough financial resources available in the firm to cover this research*

Appendix E- Web-based Survey Results

Architect's Responses

Response	Chart	Percentage	Count
I agree to participate in this study		100.0%	114
		Total Responses	**114**

Please indicate the size of architecture firm where you are currently employed (number of full-time employees):

#	Response				
1.	1	26.	1	51.	90
2.	1	27.	20	52.	Toronto District School Board
3.	4	28.	65	53.	4
4.	7	29.	9	54.	8
5.	six	30.	4	55.	23
6.	+\- 20 people including Architects, Technologists, Designers, and support staff	31.	1	56.	1
7.	35	32.	7	57.	60
8.	Small (no employees). I am self employed with my own firm.	33.	650 engineers, architects, and support staff in 17 offices across Canada	58.	5
9.	22	34.	3	59.	one
10.	500	35.	16	60.	6
11.	150	36.	9	61.	4
12.	15	37.	300	62.	30
13.	650	38.	9	63.	1
14.	4,000	39.	6	64.	1
15.	1	40.	3	65.	one
16.	18	41.	21	66.	18
17.	23	42.	4	67.	100
18.	2	43.	18	68.	105

19.	Small, 5 people	44.	18	69.	10
20.	1	45.	Gregory M. Ward Architect	70.	35
21.	14	46.	midsize	71.	260
22.	380	47.	1	72.	10
73.	Architectural/Engineering Company 9000 employees worldwide	84.	10	95.	6
74.	2	85.	15	96.	1
75.	2	86.	12	97.	4
76.	RPL ARCH	87.	5	98.	12
77.	4	88.	1	99.	12
78.	2	89.	14	100.	5
79.	12	90.	6 full time and 6 part time both Architects and Engineers	101.	1
80.	1	91.	3	102.	3
81.	2 people	92.	One Member and work with other larger firms	103.	3
82.	1	93.	500		
83.	600	94.	12		

What category of the built environment do you specialize in?

Response	Chart	Percentage	Count
Commercial		24.8%	25
Healthcare		6.9%	7
Educational		7.9%	8
Hospitality		1.0%	1
Residential		29.7%	30
Other, please specify		29.7%	30
		Total Responses	**101**

What category of the built environment do you specialize in? (Other, please specify)

#	Response	#	Response
1.	Various: Commercial , Institutional, Educational, Hospitality, etc.		
2.	green buildings	17.	not specialized
3.	Government Institutional	18.	Institutional & Educational
4.	residential	19.	40% Institutional 60% Residential
5.	Laboratory and Civic	20.	heritage
6.	Commercial, Institutional, Multi-Unit Residential	21.	Institutional/University
7.	Mixed use, Commercial, Health Care, Educational, Transit, Residential	22.	Embassies
8.	residential, commercial, hospitality	23.	Residential Commercial Institutional Industrial
9.	Industrial and transportation	24.	Industrial, mining, transport, power generation, ports
10.	municipal, multi-res, institutional	25.	Places of Worship
11.	heritage	26.	INSTITUTIONAL
12.	Residential, Heritage Conservation, Accessibility	27.	All of the above, specialty is green design
13.	all of the above	28.	All building typologies
14.	Financial Branches and Head Offices	29.	Auto dealerships
15.	Agri-tourism	30.	Industrial (Mining)
16.	commercial, healthcare, residential, recreational, museum		

How many years' experience do you have working as a licensed architect?

Response	Chart	Percentage	Count
0-5 years		21.8%	22
5-15 years		28.7%	29
15- 25 years		15.8%	16
25+ years		33.7%	34
		Total Responses	**101**

Do you have any green building/ sustainable design trainings or designations?

Response	Chart	Percentage	Count
No		43.6%	44
Yes: please specify		56.4%	57
		Total Responses	**101**

Do you have any green building/ sustainable design trainings or designations? (Yes: please specify)

#	Response		
1.	Planet Blue Ambassador	30.	Green Globes AP, LEED AP, Living Building Challenge
2.	LEED AP	31.	LEED AP
3.	LEED AP	32.	LEED AP
4.	Current sustainable "trainning" is a marketing gimmick with very little to do with sustainable practice. Having a piece of paper to hang on the wall does not make one more suited than a layman.	33.	LEED
5.	LEED / One Planet Community	34.	LEED AP
6.	LEED AP	35.	LEED
7.	LEED AP	36.	LEED AP
8.	LEEP AP BD+C	37.	LEED AP
9.	LEED AP BD+C	38.	LEED Green Associate
10.	LEED AP BD+C	39.	LEED AP BD + C
11.	LEED	40.	LEED AP
12.	Green Globes, BREEAM, LEED	41.	LEED BD+C
13.	LEED	42.	TRAININGS
14.	LEED AP	43.	LEED, PassivHaus, general
15.	LEED AP	44.	in process of passive house
16.	Passive house	45.	LEED AP
17.	LEED AP BD+C	46.	Various courses and seminars
18.	The office does	47.	LEED AP (USGBC), EnerGuide, R2000 (former delivery agent), GS Ecodesigner certified
19.	LEED AP	48.	LEED AP

20.	U of M ecology/building science/envir,physics/ engineering	49.	LEED AP
21.	LEED AP BD+C, GGP	50.	LEED
22.	LEED AP BD+C	51.	LEEDAP BD+C
23.	LEED AP	52.	One Engineer is LEED certified
24.	LEED AP	53.	LEED BC+D
25.	LEED AP	54.	LEED AP
26.	informal training but no specific designations	55.	passive house course, lots of con-ed, equest, worked with LEED
27.	LEED	56.	LEED AP
28.	LEED AP BD+C		
29.	green roof professional		

Of the total number of projects you worked on in the last two years, what percentage have been certified sustainable or green?

Response	Chart	Percentage	Count
None		38.6%	39
Less than 25%		28.7%	29
25% to less than 50%		8.9%	9
50% to less than 75%		8.9%	9
75% to 100%		14.9%	15
		Total Responses	**101**

Of the total number of interior materials you specified over the last two years, what percentage were certified environmentally preferable or green?

Response	Chart	Percentage	Count
None		16.3%	16
Less than 25%		23.5%	23
25% to less than 50%		23.5%	23
50% to less than 75%		19.4%	19
75% to 100%		17.3%	17
		Total Responses	**98**

Of your projects over the last two years in which sustainable or environmentally responsible design was/is a significant factor in the decision making process, how often did this mandate come as a project requirement from the client?

Response	Chart	Percentage	Count
Less than 25%		42.3%	33
25% to less than 50%		24.4%	19
50% to less than 75%		15.4%	12
75% to 100%		17.9%	14
		Total Responses	**78**

What is your primary motivator in specifying environmentally preferred interior materials?

Response	Chart	Percentage	Count
Required to meet project certification requirements (i.e., LEED)		12.7%	10
Request/mandate from client		10.1%	8
Mission of firm		34.2%	27
Personal values		32.9%	26
Other, please describe:		10.1%	8
		Total Responses	**79**

What is your primary motivator in specifying environmentally preferred interior materials? (Other, please describe:)

#	Response
1.	all of the above
2.	Default requirement for commercial tenants. As long as it says "certified green or LEED x" they are happy. That's all they care about: Their image.
3.	Professional environmental/ construction knowledge
4.	Personal values if you need only one, but in reality all answers impact the decision.
5.	Cost
6.	where appropriate - any / all of the above
7.	healthy interior for occupants
8.	Environmental health, I suppose it is a mission or values also.

When specifying environmentally preferred materials, what resource do you primarily use to make selection decisions?

Response	Chart	Percentage	Count
Materials library (within firm)		19.0%	15
In-firm materials specifier		3.8%	3
Manufacturer's literature (online or print)		63.3%	50
Online green materials eco-database (Please list all that you use:)		7.6%	6
Eco-label/certification organization (Please list all that you use:)		6.3%	5
		Total Responses	**79**

When specifying environmentally preferred materials, what resource do you primarily use to make selection decisions? (Online green materials eco-database (Please list all that you use:))

#	Response
1.	Follow recommendations in Living Building Challenge - Red List http://declareproducts.com/content/declare-and-living-building-challenge
2.	GIGA MATTER DATABASE
3.	Building Green
4.	Green Building News

When specifying environmentally preferred materials, what resource do you primarily use to make selection decisions? (Eco-label/certification organization (Please list all that you use:))

#	Response
1.	LEED LBC BREEAM
2.	Cradle to cradle or green guard
3.	EPDs, Sustainable Forestry Initiative, EcoLogo, Indoor Advantage Gold, Green Seal, GREENGUARD, FloorScore, CSA, Forestry Stewardship, Green Label®, Council, American Tree Farm System
4.	The Architects Reference Library (Phoenix)

What label and/or supporting documentation is the most important to you when specifying an environmentally preferable material?

Response	Chart	Percentage	Count
Green building rating system credit potential (please identify which system:)		22.9%	16

EPD (Environmental Product Declaration)		21.4%	15
LCA Study/Report (Life Cycle Assessment)		10.0%	7
Material ingredients		24.3%	17
Eco-label/environmental product certification (please identify:)		8.6%	6
Other, please specify:		12.9%	9
		Total Responses	**70**

What label and/or supporting documentation is the most important to you when specifying an environmentally preferable material? (Green building rating system credit potential (please identify which system:))

#	Response		
1.	Green Globes	7.	LEED
2.	LEED	8.	LEED
3.	LEED / PASSIVE HAUS	9.	Green guard
4.	LEED 2009 Canada for NC	10.	LEED
5.	LEED and Green Globes	11.	LEED
6.	FSC, Green Guard, Green Seal,	12.	Canada Green Building Council member

What label and/or supporting documentation is the most important to you when specifying an environmentally preferable material? (Eco-label/environmental product certification (please identify:))

#	Response
1.	C2C or Floor Score

What label and/or supporting documentation is the most important to you when specifying an environmentally preferable material? (Other, please specify:)

#	Response
1.	Labels are for marketing purposes. I choose based on the need of the project using whatever resource is most applicable. In short: it varies.
2.	I try to understand all the criteria that includes materials, local/distance traveled and embodied energy/carbon footprint
3.	Best practices: low VOCs, recycled materials, long life materials, natural products
4.	Label/Documentation is specific to each product; FSC-wood, FloorScore-Flooring, MSDS compliance to SCAQMD, etc
5.	labels are chaotic, personal values, nature, minimum residue, etc

6.	Depends on the product
7.	ULC approved or CSA
8.	It's not important, as long as there is info to support it
9.	Common sense. Simplicity of process(ing), renewability, locality, energy and carbon intensity, and importantly, volume or quantity of each. Ie. we aim to minimize steel and concrete wherever possible.

Which eco-label or environmental product certification do you most often include in interior material product specifications?

#	Response		
1.	fuzzy	25.	LEED or Green Globes
2.	CAGBC, GBC	26.	The Canadian EcoLogo
3.	None. It depends on the application and there is far too much green-washing to be confident in one marketing label over another	27.	meaningless
4.	None most often. I often look beyond the label to make sure greenwashing isn't happening. I call, ask questions.	28.	FSC
5.	Floor Score	29.	LEED
6.	FSC or green guard	30.	FSA
7.	http://declareproducts.com/content/declare-and-living-building-challenge	31.	Uncertain
8.	EcoLogo	32.	CSA
9.	-	33.	LEED
10.	Fsc	34.	NA
11.	Varies	35.	Green Label Plus
12.	EPD	36.	Wood Stewardship Council
13.	Wood certifications: renewable forestry, etc.	37.	LEEDS
14.	Low or no VOC	38.	FSC
15.	Decisions are not based on labels - based on building science & testing knowledge	39.	none
16.	GreenGuard	40.	air quality emissions of product and recycled content
17.	EPD	41.	ecologo, FSC (or other certified forest products)

18.	FSC	42.	Green guard - floor finished, engineered wood, drywall
19.	EcoLogo (Terrachoice)	43.	Flooring
20.	non petroleum-based, no/ low VOC, FSC,	44.	n/a
21.	no specific label in our specifications	45.	ecolabel
22.	varies	46.	GreenGuard comes to mind.
23.	FloorScore	47.	LEED
24.	this question is to broad, each material has different product certification requirements	48.	Canada Green Building Council member

Why is the aforementioned eco-label(s) or environmental product certification system(s) the most often utilized when specifying environmentally preferred interior materials? Please rank the three most relevant from 1 to 3 (with 1 being the most relevant)

	1	2	3	Total Responses
Number of products to choose from	6 (27.3%)	8 (36.4%)	8 (36.4%)	22
Personal understanding of certification process	3 (17.6%)	7 (41.2%)	7 (41.2%)	17
Required for project mandate (i.e., LEED)	10 (43.5%)	4 (17.4%)	9 (39.1%)	23
Aesthetic attributes	5 (29.4%)	9 (52.9%)	3 (17.6%)	17
Performance/durability	18 (50.0%)	14 (38.9%)	4 (11.1%)	36
Marketing or visibility of manufacturer or product	8 (29.6%)	5 (18.5%)	14 (51.9%)	27
Other, please specify	5 (50.0%)	2 (20.0%)	3 (30.0%)	10

When an eco-label or environmental product certification is not available for an interior material, what are the most important factors to you in selecting an environmentally preferred product? Please rank in order from 1 to 7 (with 1 being the most important).

	1	2	3	4	5	6	7	Total Responses
Regional material(s)	14 (30.4%)	12 (26.1%)	6 (13.0%)	4 (8.7%)	4 (8.7%)	4 (8.7%)	2 (4.3%)	46
Rapidly renewable material	6 (14.3%)	6 (14.3%)	9 (21.4%)	6 (14.3%)	5 (11.9%)	7 (16.7%)	3 (7.1%)	42
Manufacturing	1	5	9	11	8	7	1	42

process	(2.4%)	(11.9%)	(21.4%)	(26.2%)	(19.0%)	(16.7%)	(2.4%)	
Manufacturing location	2 (4.7%)	8 (18.6%)	6 (14.0%)	7 (16.3%)	13 (30.2%)	4 (9.3%)	3 (7.0%)	43
Material ingredient disclosure	12 (25.5%)	5 (10.6%)	5 (10.6%)	7 (14.9%)	9 (19.1%)	5 (10.6%)	4 (8.5%)	47
Performance/life-cycle	15 (30.6%)	8 (16.3%)	9 (18.4%)	6 (12.2%)	4 (8.2%)	5 (10.2%)	2 (4.1%)	49
End-of-life options (i.e., landfill)	3 (6.1%)	8 (16.3%)	6 (12.2%)	4 (8.2%)	3 (6.1%)	10 (20.4%)	15 (30.6%)	49
Other (please specify below)	1 (14.3%)	0 (0.0%)	0 (0.0%)	1 (14.3%)	0 (0.0%)	0 (0.0%)	5 (71.4%)	7

Please identify other important decision-making factors:

#	Response		
1.	aesthetics	8.	local availability, cost
2.	Healthy/ Non toxic for people or the earth	9.	health effects
3.	Delivery time from placement of order	10.	All must be assessed and balanced.
4.	Past experience with the product	11.	Aesthetic look and performance
5.	VOC, CO2, supply chain (extraction, packaging plus manufacturing and travel distance already included above) impacts	12.	Company's business model
6.	Availability, Cost, Client Preference, Personal Preference	13.	Durability and aesthetic timelessness (i.e. it doesn't look outdated 5 years on)
7.	Material sustainability and durable esthetic value	14.	Beauty
		15.	Recyclable

In your professional opinion, please rank the importance of the environmental factors below when selecting materials: Please rank in order from 1 to 7 (with 1 being the most important)

	1	2	3	4	5	6	7	Total Responses

Regional material/transportation impacts	6 (12.5%)	8 (16.7%)	8 (16.7%)	10 (20.8%)	8 (16.7%)	7 (14.6%)	1 (2.1%)	48
Rapidly renewable material	8 (16.3%)	4 (8.2%)	10 (20.4%)	10 (20.4%)	9 (18.4%)	8 (16.3%)	0 (0.0%)	49
Recycled Content/ Recyclability	3 (6.2%)	18 (37.5%)	9 (18.8%)	1 (2.1%)	11 (22.9%)	5 (10.4%)	1 (2.1%)	48
Indoor Air Quality/ Toxicity	20 (42.6%)	5 (10.6%)	6 (12.8%)	8 (17.0%)	3 (6.4%)	4 (8.5%)	1 (2.1%)	47
Embodied Energy	4 (8.5%)	5 (10.6%)	13 (27.7%)	9 (19.1%)	6 (12.8%)	9 (19.1%)	1 (2.1%)	47
Life-cycle (including end-of-life)	11 (20.4%)	7 (13.0%)	6 (11.1%)	8 (14.8%)	10 (18.5%)	9 (16.7%)	3 (5.6%)	54
Other, please specify below:	3 (30.0%)	1 (10.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (10.0%)	5 (50.0%)	10

Please identify other environmental factors:

#	Response		
1.	light pollution, heat island	5.	Reusability
2.	Cost	6.	Reusability of durable items with high embodied energy
3.	Quality/Workmanship	7.	which country may be impacted by the material selection
4.	Durability, longevity of material, suitable material for the particular application.	8.	Volume or quantity - almost never a factor in LEED certification. ie. 100 tons of concrete better than 500...

When a client requests environmentally preferred materials, how do they rank the environmental factors below? Please rank in order from 1 to 7 (with 1 being the most important).

	1	2	3	4	5	6	7	Total Responses
Regional material/transportation impacts	5 (12.8%)	6 (15.4%)	7 (17.9%)	9 (23.1%)	6 (15.4%)	4 (10.3%)	2 (5.1%)	39
Rapidly renewable material	2 (5.0%)	7 (17.5%)	7 (17.5%)	5 (12.5%)	12 (30.0%)	5 (12.5%)	2 (5.0%)	40
Recycled Content/ Recyclability	8 (19.5%)	11 (26.8%)	11 (26.8%)	6 (14.6%)	2 (4.9%)	3 (7.3%)	0 (0.0%)	41

Indoor Air Quality/ Toxicity	11 (27.5%)	7 (17.5%)	7 (17.5%)	10 (25.0%)	3 (7.5%)	2 (5.0%)	0 (0.0%)	40
Embodied Energy	0 (0.0%)	2 (5.1%)	7 (17.9%)	4 (10.3%)	9 (23.1%)	14 (35.9%)	3 (7.7%)	39
Life-cycle (including end-of-life)	11 (25.0%)	10 (22.7%)	2 (4.5%)	7 (15.9%)	6 (13.6%)	7 (15.9%)	1 (2.3%)	44
Other, please specify below	8 (53.3%)	1 (6.7%)	1 (6.7%)	1 (6.7%)	0 (0.0%)	0 (0.0%)	4 (26.7%)	15

Please identify other environmental factors from client:

#	Response		
1.	cost	9.	Cost of Environmentally Preferred over Standard
2.	Cost	10.	To be honest, clients rarely care.
3.	Cost	11.	Look
4.	Cost	12.	no preference or opinion is offered for most cases. This is designers issue.
5.	consultant's advice	13.	they do not rank factors, the culture is missing
6.	Cost	14.	Reusability
7.	Cost	15.	We have many clients and I cannot answer for them. Typically cost is the main motivating factor in all decisions, not the environment.
8.	COST, number 1.	16.	Cost
		17.	Um, cost!

Please indicate the importance of material ingredient disclosure (ingredient transparency) to you when specifying an interior material:

Response	Chart	Percentage	Count
Very important; all material ingredients must be disclosed		63.6%	35
Somewhat important; ingredient disclosure would help in selection process		27.3%	15
Not very important; other environmental factors trump ingredient transparency		5.5%	3
Materials are not selected based on ingredient disclosure		3.6%	2

		Total Responses	**55**

Are there interior material ingredient(s) that you avoid due to adverse environmental impacts?

Response	Chart	Percentage	Count
No		18.2%	10
Yes (please list:)		81.8%	45
		Total Responses	**55**

Are there interior material ingredient(s) that you avoid due to adverse environmental impacts? (Yes (please list:))

#	Response
1.	high VOC's
2.	exotic woods
3.	Formaldehyde, Spray Foam, all VOC's
4.	Formaldehyde, arsenic, other carcinogens
5.	Anything that off gasses, PVC, red list materials (when possible)
6.	tropical wood
7.	VOC's etc.
8.	VOCs primarily, plastics, no -renewables
9.	Formaldehyde, Plastic Fabrics,
10.	Anything that isn't healthy
11.	Drywall Plastics Phenol Formaldehyde binders pressure treated wood
12.	VOCs
13.	HIgh VOC materials
14.	petroleum
15.	VOCs, Formeldahyde, PVCs.
16.	Heavily processed, non-renewable materials
20.	CFCs, Vinyl, Asbestos
21.	Fiberglass insulation
22.	pvc
23.	too many
24.	lead, mercury, formaldehyde, cadmium, toluene, asbestos, coal tar, phthalates etc
25.	voc off-gassing products, ozone depleting materials, etc.
26.	added formaldehyde, VOC, etc
27.	Asbestos...huge list here
28.	plastics
29.	products that have strong off-gassing
30.	VOC's
31.	Rubber, Mahogany. Old Growth Forest wood
32.	lead based anything
33.	vocs exotic woods items that don't stand up to use that will end up landfill
34.	any carcinogenic

17.	high VOC, urea formaldehyde	35.	See German federal regulations, as they are more stringent than ours, re. PVC, Mineral Fibre, Glass Fibre, etc.
18.	vocs	36.	anything with heavy metals - lead/aluminum; formaldehyde.
19.	non-NAUF wood, PVC,	37.	PVC
		38.	We avoid products with environmentally destructive manufacturing processes, low recycling ability, high embodied energy.

Do you have experience in working with, and specifying materials for, LEED v4 Material & Resources credits:

Response	Chart	Percentage	Count
Yes		42.9%	24
No		57.1%	32
		Total Responses	**56**

Which of the available LEED v4 Materials and Resources credits are most commonly utilized on your current projects (or are referenced if using LEED v4 as a template for sustainable building systems) – select all that apply:

Response	Chart	Percentage	Count
Building life-cycle impact reduction (MRc1)		66.7%	16
Building product disclosure and optimization - environmental product declarations (MRc2)		58.3%	14
Building product disclosure and optimization - sourcing of raw materials (MRc3)		37.5%	9
Building product disclosure and optimization - material ingredients (MRc4)		50.0%	12
		Total Responses	**24**

Do you have experience in working with, and specifying materials using, the Cradle to Cradle (C2C) product certification system:

Response	Chart	Percentage	Count
Yes		21.8%	12
No		78.2%	43
		Total Responses	**55**

Do you experience barriers in specifying products with C2C certification?

Response	Chart	Percentage	Count
Yes (please explain:)		41.7%	5
No		58.3%	7
		Total Responses	**12**

Do you experience barriers in specifying products with C2C certification? (Yes (please explain:))

#	Response
1.	there are very few and higher cost
2.	Limited products, needs more database and products on board with mission
3.	Market availability
4.	Cost
5.	experience has been limited to furnishings not always available for products

Do you have experience in working with, and specifying interior materials with EPDs (environmental product declarations):

Response	Chart	Percentage	Count
Yes		38.2%	21
No		61.8%	34
		Total Responses	**55**

Do you experience barriers in specifying products with EPDs?

Response	Chart	Percentage	Count
Yes (please explain:)		47.6%	10
No		52.4%	11
		Total Responses	**21**

Do you experience barriers in specifying products with EPDs? (Yes (please explain:))

#	Response
1.	Need to understand what the ingredients mean to human and environmental health
2.	Many product manufacturers are not honest tine their disclosures
3.	New system. Not all manufacturers have them.
4.	obtaining information, relative cost, performance
5.	Currently working on 4 LEED V4 projects

6.	cost
7.	Costs sometimes because there are few manufacturers who supply EPDs and they are undercut by cheaper products. Budget trumps it in public projects if the Owner group are not committed to the ideal
8.	not all manufacturers have EPDs for their products
9.	Manufacturers often are not aware themselves, or are not aware of post-processing
10.	Not widely adopted in industry. Smaller players locked out.

Does the availability of an EPD assist in selecting an environmentally preferred interior material?

Response	Chart	Percentage	Count
Yes		90.5%	19
No		9.5%	2
		Total Responses	**21**

Do you have experience in working, and specifying interior materials, with LCAs (life-cycle assessments):

Response	Chart	Percentage	Count
Yes		40.0%	22
No		60.0%	33
		Total Responses	**55**

Do you experience barriers in specifying products with LCA reports?

Response	Chart	Percentage	Count
Yes (please explain:)		31.8%	7
No		68.2%	15
		Total Responses	**22**

Do you experience barriers in specifying products with LCA reports? (Yes (please explain:))

#	Response
2.	Clients that only care about first cost and not lowest life cycle costs (either developers or money comes from different departments)
3.	Few manufacturers have this data available
4.	Client experience and knowledge with this
5.	Encounter resistance sometimes because upfront capital costs might be higher than other options

6.	information availability, costs
7.	lack of products available with LCA's

Does the availability of an LCA report assist in selecting an environmentally preferred interior material?

Response	Chart	Percentage	Count
Yes		81.0%	17
No		19.0%	4
		Total Responses	**21**

What do you feel are the biggest barriers to specifying environmentally preferred interior materials (select all that apply):

Response	Chart	Percentage	Count
Lack of product selection for environmentally preferred interior materials		33.3%	23
Lack of information on benefits		29.0%	20
Unclear of product certification processes		33.3%	23
No common or clear product label(s) or standard(s)		43.5%	30
Not required to meet project/client requirements		43.5%	30
Not enough time to conduct research to make decisions		33.3%	23
Other, please specify:		24.6%	17
		Total Responses	**69**

What do you feel are the biggest barriers to specifying environmentally preferred interior materials (select all that apply): (Other, please specify:)

#	Response		
1.	Cost	9.	not the kind of work we do for our client groups
2.	Used than and no need for approvals	10.	missing culture
3.	Mfr.'s inability to substantiate claims	11.	carbon dioxide is a clear, colorless, odorless, inert gas and its contribution to global warming is infinitesimal and its reduction would not have a cost benefit.
4.	LEED and labeling bypass independent evaluation, science	12.	fire ratings

	add bias		
5.	Cost Premiums	13.	Cost
6.	LCA is the manufacturer's responsibility.	14.	Cost prohibitive
7.	above selections mostly from client and/or contractor point of view as to the importance	15.	cost
8.	Lack of Support through third party project managers, misinformation and common misunderstandings	16.	BUILDING CODE is the major barrier to good sustainable design

Interior Designer's Web-based Survey Responses

Response	Chart	Percentage	Count
I agree to participate in this study		100.0%	119
		Total Responses	**119**

Please indicate the size of design firm where you are currently employed (number of full-time employees):

#	Response				
1.	1200+	36.	One full-time designer.	71.	35
2.	14	37.	3	72.	4
3.	one	38.	80+	73.	60
4.	24	39.	1	74.	3
5.	2	40.	19	75.	12
6.	fourteen	41.	16	76.	2
7.	15	42.	17	77.	unemployed
8.	2	43.	5	78.	1
9.	45	44.	12	79.	28 people
10.	2000+	45.	35	80.	40
11.	1-5	46.	1	81.	400
12.	7	47.	15	82.	3
13.	4	48.	1	83.	20
14.	one	49.	1	84.	2
15.	1	50.	1500+	85.	1
16.	5	51.	n/a	86.	6
17.	0	52.	n/a I work for a hospital	87.	8
18.	20	53.	1	88.	50
19.	3	54.	one	89.	0
20.	5	55.	50	90.	6
21.	1	56.	1	91.	2
22.	3	57.	1	92.	2
23.	0	58.	100+	93.	2
24.	50	59.	2	94.	4

25.	150	60.	150	95.	1
26.	I am a Registered Interior Designer working for a Manufacturer. We have 5000+ employees	61.	15	96.	1
27.	1000+	62.	6	97.	1
28.	140	63.	10	98.	150
29.	I work for the Department of Public Service and Procurement Canada- formally known as PWGSC in Real Property Branch. approx 300 in the National Capital Area	64.	4	99.	1800
30.	5	65.	13	100.	2
31.	30	66.	800	101.	1
32.	300 Employees	67.	15	102.	Approx. 40
33.	1	68.	3	103.	Self Employed
34.	7	69.	15	104.	6
35.	7	70.	one designer		

What field of interior design do you specialize in?

Response	Chart	Percentage	Count
Commercial		41.0%	43
Healthcare		6.7%	7
Educational		2.9%	3
Hospitality		4.8%	5
Residential		25.7%	27
Other, please specify		19.0%	20
		Total Responses	**105**

What field of interior design do you specialize in? (Other, please specify)

#	Response
1.	all of the above
2.	retail
3.	Retail Design
4.	All of the above, except Hospitality
5.	Almost 50/50 Commercial and Residential
6.	Commercial, Retail and Multi Unit Residential
7.	Institutional - Healthcare and Education
8.	Government
9.	Unique Spa experiences Canada wide
10.	Retail
11.	Residential(High Rise) & Retirement Residences
12.	Exhibit Design
13.	development
14.	Property Management
15.	commercial, healthcare, educational,
16.	Mix of commercial and educational
17.	All
18.	Religious
19.	We do all of the above except residential
20.	multi res

How many years' experience do you have working as a registered interior designer?

Response	Chart	Percentage	Count
0-5 years		18.3%	19
5-15 years		23.1%	24
15- 25 years		26.0%	27
25+ years		32.7%	34
		Total Responses	**104**

Do you have any green building/ sustainable design trainings or designations?

Response	Chart	Percentage	Count
No		55.8%	58
Yes: please specify		44.2%	46
		Total Responses	**104**

Do you have any green building/ sustainable design trainings or designations? (Yes: please specify)

#	Response
1.	LEED BD+C
23.	Have taken LEED courses and participated in study sessions. Never wrote the exam.

2.	LEED AP	24.	LEED A.P.
3.	Professor at a college and up to date with information	25.	LEED AP ID+C
4.	LEED AP	26.	LEED AP
5.	LEED AP	27.	LEED AP
6.	LEED AP	28.	LEED
7.	LEED ID+C	29.	Graduate certificate in Green Architecture
8.	LEED AP ID+C	30.	Member of the Canadian Green Building Council
9.	LEED AP ID+C	31.	LEED AP ID+C
10.	LEED AP, LEED ID+C, Living Building Challenge Ambassador and Facilitator	32.	LEED AP ID+C
11.	LEED AP ID +C	33.	LEED AP ID+C
12.	LEED	34.	LEED AP
13.	LEED AP	35.	CGBC
14.	LEED green associate	36.	LEED
15.	LEED AP ID+C	37.	Certified Environmental Management (Ryerson)
16.	LEED AP ID&C	38.	LEED
17.	LEED AP	39.	LEED AP Commercial Interiors
18.	LEED GA, sustainable management certificate	40.	LEED AP
19.	Con Ed courses	41.	Led AP
20.	LEEP AP	42.	LEED GA
21.	ceu's	43.	LEED AP ID & C
22.	LEEP AP	44.	LEED-AP ID+C

Of the total number of projects you worked on in the last two years, what percentage have been certified sustainable or green?

Response	Chart	Percentage	Count
None		59.6%	62
Less than 25%		16.3%	17
25% to less than 50%		9.6%	10

50% to less than 75%		5.8%	6
75% to 100%		8.7%	9
		Total Responses	**104**

Of the total number of interior materials you specified over the last two years, what percentage were certified environmentally preferable or green?

Response	Chart	Percentage	Count
None		2.9%	3
Less than 25%		25.5%	26
25% to less than 50%		29.4%	30
50% to less than 75%		22.5%	23
75% to 100%		19.6%	20
		Total Responses	**102**

Of your projects over the last two years in which sustainable or environmentally responsible design was/is a significant factor in the decision making process, how often did this mandate come as a project requirement from the client?

Response	Chart	Percentage	Count
Less than 25%		61.9%	60
25% to less than 50%		16.5%	16
50% to less than 75%		13.4%	13
75% to 100%		8.2%	8
		Total Responses	**97**

What is your primary motivator in specifying environmentally preferred interior materials?

Response	Chart	Percentage	Count
Required to meet project certification requirements (i.e., LEED)		9.3%	9
Request/mandate from client		8.2%	8
Mission of firm		20.6%	20
Personal values		56.7%	55
Other, please describe:		5.2%	5
		Total Responses	**97**

What is your primary motivator in specifying environmentally preferred interior materials? (Other, please describe:)

#	Response
1.	Good design practice
2.	Personal values and mission of the firm...my firm.
3.	municipality restrictions on materials
4.	Personal values dictate reviewing the actual environmental benefit; it usually seems to be a vague cultural preference for "being green" motivating the client side - this makes it easy to get approval on an idea described as "green" but most clients (and many designers I have worked with) have little idea of what their choice actually represents in measurable terms
5.	Educate clients about the advantages of sustainable/green design economically and for employee well-being.

When specifying environmentally preferred materials, what resource do you primarily use to make selection decisions?

Response	Chart	Percentage	Count
Materials library (within firm)		27.8%	27
In-firm materials specifier		3.1%	3
Manufacturer's literature (online or print)		64.9%	63
Online green materials eco-database (Please list all that you use:)		3.1%	3
Eco-label/certification organization (Please list all that you use:)		1.0%	1
		Total Responses	**97**

When specifying environmentally preferred materials, what resource do you primarily use to make selection decisions? (Online green materials eco-database (Please list all that you use:))

#	Response
1.	Cradle 2 Cradle, Good Guide, My Greener House (prior to it closing)

When specifying environmentally preferred materials, what resource do you primarily use to make selection decisions? (Eco-label/certification organization (Please list all that you use:))

#	Response
1.	Greeguard, cradle to cradle, LEED credit contributing material

What label and/or supporting documentation is the most important to you when specifying an environmentally preferable material?

Response	Chart	Percentage	Count

Green building rating system credit potential (please identify which system:)	10.4%	10
EPD (Environmental Product Declaration)	22.9%	22
LCA Study/Report (Life Cycle Assessment)	16.7%	16
Material ingredients	30.2%	29
Eco-label/environmental product certification (please identify:)	7.3%	7
Other, please specify:	12.5%	12
	Total Responses	**96**

What label and/or supporting documentation is the most important to you when specifying an environmentally preferable material? (Green building rating system credit potential (please identify which system:))

#	Response		
1.	US/CAGBC	5.	LEED / BREAM
2.	Cradle to Cradle, Greenguard, LEED compliant	6.	LEED
3.	LEED	7.	LEED
4.	LEED	8.	Greenguard, LEED, BIFMA level certifications.

What label and/or supporting documentation is the most important to you when specifying an environmentally preferable material? (Eco-label/environmental product certification (please identify:))

#	Response
1.	Varies depending on the type of product
2.	EcoLogo, Cradle to Cradle, FSC, Energy Star etc.
3.	product specific, greenseal / CRI green label plus etc
4.	Canada Green Building Council (or US)
5.	Green Building Association, LEED

What label and/or supporting documentation is the most important to you when specifying an environmentally preferable material? (Other, please specify:)

#	Response		
1.	It depends on the product that you are specifying. Each product has their own governance. I.e. FSC, etc.	7.	LEED, Green Globe, FSC Certification
2.	not sure	8.	Manufacturer's literature and the Testing data

			results.
3.	combination EPD /LCA /material ingredients	9.	I've never requested supporting doc's
4.	Research of manufacturing process and recycling program offered by the manufacturer.	10.	Greenguard
5.	whatever is most relevant to the specific product	11.	EPD & LCA are wonderful when we can get them for all the competing options and the client is willing to pay the fees for research - we default to 3rd party certifications and scrutiny of manufacturer's claims
6.	Manufacturer's Information	12.	cradle to cradle

Which eco-label or environmental product certification do you most often include in interior material product specifications?

#	Response		
1.	US/CAGBC	33.	too many different products to say...LEED is one.
2.	N/A	34.	FSC
3.	It is usually standardized in our Specification manual	35.	LEED
4.	if it's LEED accredited	36.	never done it
5.	Cradle-to-cradle	37.	LCA
6.	Don't specify the certification, but rather choose the specific product to specify	38.	FSC, NSF, Oeko-Tex, Greenguard
7.	Greenguard, CRI, Floorscore, etc	39.	LEED
8.	look for product content rather than product certification	40.	Greenguard
9.	Fsc	41.	n/a
10.	Canada Green Building Council	42.	green label, fsc
11.	Ecologo	43.	FSC - ISO 14001
12.	FSC or GreenGuard	44.	FSC, Cradle to Cradle
13.	not sure, there are many that come up for the products that we frequently use. (ex. Tandus carpet)	45.	FSC
14.	Recyclable	46.	Greenguard

15.	FloorScor Certified	47.	None
16.	Indoor air quality labels: Greeguard / Floorscore / Carpet and Rug insititute	48.	We tend to use closed specifications. MPI categories would be our most common simply because we use paint on every project.
17.	none	49.	Meets California Section 01350 Indoor Air Quality Standard (Low VOC)
18.	recycled content	50.	Green Building Association
19.	LEED	51.	We ensure that materials specified are environmentally friendly based on product information and sustainable certification (see previous answer)
20.	Green Building Certification Canada	52.	cradle to cradle
21.	LEEP CI guidelines	53.	Greenguard
22.	Green building standards	54.	FSC
23.	Oeko Tex Standard 100 (confidence in textiles, tested for harmful substances)	55.	NFPA
24.	FSC	56.	FSC, Ecologo. level
25.	I don't use just one, they tend to differ per product type. ie) carpet eco-label is different from that for paint, solid surface flooring, FSC wood etc	57.	it depends upon the type of product - question is not specific enough so therefore difficult to answer properly - most often not always relevant
26.	Recycled content	58.	recycled content, low voc
27.	Cradle to Cradle	59.	paint
28.	Canada Green Building Council	60.	forestry products
29.	Energy Star & EnerGuide	61.	Energy Star
30.	Usually don't include it	62.	Greenguard certified
31.	non-VOC, FSC	63.	LEED
32.	FSC	64.	LEED

Why is the aforementioned eco-label(s) or environmental product certification system(s) the most often utilized when specifying environmentally preferred interior materials? Please rank the three most relevant from 1 to 3 (with 1 being the most relevant)

	1	2	3	Total Responses
Number of products to choose from	12 (38.7%)	8 (25.8%)	11 (35.5%)	31
Personal understanding of certification process	11 (33.3%)	10 (30.3%)	12 (36.4%)	33
Required for project mandate (i.e., LEED)	15 (40.5%)	6 (16.2%)	16 (43.2%)	37
Aesthetic attributes	3 (13.6%)	14 (63.6%)	5 (22.7%)	22
Performance/durability	25 (53.2%)	13 (27.7%)	9 (19.1%)	47
Marketing or visibility of manufacturer or product	7 (20.0%)	18 (51.4%)	10 (28.6%)	35
Other, please specify	2 (40.0%)	0 (0.0%)	3 (60.0%)	5

When an eco-label or environmental product certification is not available for an interior material, what are the most important factors to you in selecting an environmentally preferred product? Please rank in order from 1 to 7 (with 1 being the most important).

	1	2	3	4	5	6	7	Total Responses
Regional material(s)	9 (13.0%)	13 (18.8%)	11 (15.9%)	8 (11.6%)	8 (11.6%)	11 (15.9%)	9 (13.0%)	69
Rapidly renewable material	10 (15.4%)	6 (9.2%)	9 (13.8%)	12 (18.5%)	9 (13.8%)	10 (15.4%)	9 (13.8%)	65
Manufacturing process	3 (4.5%)	7 (10.6%)	14 (21.2%)	13 (19.7%)	10 (15.2%)	12 (18.2%)	7 (10.6%)	66
Manufacturing location	8 (11.6%)	11 (15.9%)	8 (11.6%)	11 (15.9%)	12 (17.4%)	11 (15.9%)	8 (11.6%)	69
Material ingredient disclosure	15 (23.1%)	8 (12.3%)	11 (16.9%)	9 (13.8%)	11 (16.9%)	6 (9.2%)	5 (7.7%)	65
Performance/life-cycle	28 (36.8%)	11 (14.5%)	11 (14.5%)	8 (10.5%)	8 (10.5%)	9 (11.8%)	1 (1.3%)	76
End-of-life options (i.e., landfill)	4 (5.1%)	19 (24.4%)	10 (12.8%)	7 (9.0%)	12 (15.4%)	6 (7.7%)	20 (25.6%)	78
Other (please specify below)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	3 (100.0%)	3

Please identify other important decision-making factors:

#	Response	#	Response
1.	Cost	8.	COST, AESTHETIC, PERFORMANCE, DURABILITY, PRODUCT SUPPORT, LOCAL PRODUCT
2.	knowledge of makers ethics and belief in sustainability	9.	Form not letting me select more than one, sorry.

3.	Manufacturer does not use green washing and has evidence based design and scientific data to back it up	10.	Available data and testing
4.	is there an added cost to having this label	11.	allergy reactions or sensitivity issues
5.	Life cycle. Recycling, buy back programs, resell (Repair) of existing used products for resell by manufacturer's	12.	If the company has a mandate to support eco-friendly initiatives above and beyond their products.
6.	aesthetic appeal, durability, natural fibers	13.	recycled content
7.	The cost of the material plays an important part in the design process in relationship to the client's project requirements.	14.	Has to be aesthetically pleasing to work with design, and sustainable. Recycled content is good too.
		15.	Knowledge of the product

In your professional opinion, please rank the importance of the environmental factors below when selecting materials: Please rank in order from 1 to 7 (with 1 being the most important)

	1	2	3	4	5	6	7	Total Responses
Regional material/transportation impacts	5 (6.8%)	14 (19.2%)	12 (16.4%)	14 (19.2%)	16 (21.9%)	11 (15.1%)	1 (1.4%)	73
Rapidly renewable material	7 (10.1%)	10 (14.5%)	12 (17.4%)	20 (29.0%)	11 (15.9%)	8 (11.6%)	1 (1.4%)	69
Recycled Content/ Recyclability	13 (18.6%)	15 (21.4%)	19 (27.1%)	9 (12.9%)	11 (15.7%)	3 (4.3%)	0 (0.0%)	70
Indoor Air Quality/ Toxicity	31 (41.9%)	17 (23.0%)	13 (17.6%)	5 (6.8%)	4 (5.4%)	3 (4.1%)	1 (1.4%)	74
Embodied Energy	0 (0.0%)	8 (11.4%)	7 (10.0%)	14 (20.0%)	8 (11.4%)	29 (41.4%)	4 (5.7%)	70
Life-cycle (including end-of-life)	21 (26.6%)	10 (12.7%)	13 (16.5%)	8 (10.1%)	17 (21.5%)	8 (10.1%)	2 (2.5%)	79
Other, please specify below:	0 (0.0%)	1 (6.2%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (6.2%)	14 (87.5%)	16

Please identify other environmental factors:

#	Response		
1.	Cost	7.	There is also and environmental impact to the demolition process when dealing with interiors and how removal of material impacts air quality both inside and out.
2.	Demonstrated reduced environmental impacts	8.	Sorry, form not letting me select more than one line item.
3.	Durability	9.	Installation method
4.	contributions to regeneration	10.	resistance to sunlight exposure & cold.
5.	Limited use of the oil industry	11.	Water consumption during the manufacturing process
6.	Using materials to minimize demolition and disposals as much as possible.	12.	FSC certified wood

When a client requests environmentally preferred materials, how do they rank the environmental factors below? Please rank in order from 1 to 7 (with 1 being the most important).

	1	2	3	4	5	6	7	Total Responses
Regional material/transportation impacts	3 (5.4%)	5 (8.9%)	12 (21.4%)	14 (25.0%)	12 (21.4%)	7 (12.5%)	3 (5.4%)	56
Rapidly renewable material	1 (1.9%)	7 (13.0%)	13 (24.1%)	17 (31.5%)	11 (20.4%)	5 (9.3%)	0 (0.0%)	54
Recycled Content/ Recyclability	17 (29.3%)	11 (19.0%)	13 (22.4%)	7 (12.1%)	8 (13.8%)	1 (1.7%)	1 (1.7%)	58
Indoor Air Quality/ Toxicity	27 (45.0%)	23 (38.3%)	4 (6.7%)	3 (5.0%)	0 (0.0%)	2 (3.3%)	1 (1.7%)	60
Embodied Energy	0 (0.0%)	2 (3.6%)	5 (8.9%)	3 (5.4%)	14 (25.0%)	28 (50.0%)	4 (7.1%)	56
Life-cycle (including end-of-life)	10 (16.7%)	6 (10.0%)	10 (16.7%)	12 (20.0%)	10 (16.7%)	8 (13.3%)	4 (6.7%)	60
Other, please specify below	5 (27.8%)	2 (11.1%)	0 (0.0%)	2 (11.1%)	0 (0.0%)	1 (5.6%)	8 (44.4%)	18

Please identify other environmental factors from client:

#	Response		
1.	Frankly, no clients ask for environmentally friendly materials. It is a little shocking.	8.	Sorry, form not letting me select more than one line item.
2.	Unknown	9.	price
3.	Disposal	10.	most clients have little awareness of much other than recycling and IAQ
4.	unknown	11.	Installation methods and adhesion materials
5.	contribution to LEED	12.	LEED credits
6.	Quite often the client doesn't go further than what has been discussed above other than how to get rid of the demolition debris.	13.	durability to sunlight
7.	cost	14.	Water conservation and consumption during the manufacturing process

Please indicate the importance of material ingredient disclosure (ingredient transparency) to you when specifying an interior material:

Response	Chart	Percentage	Count
Very important; all material ingredients must be disclosed		64.2%	52
Somewhat important; ingredient disclosure would help in selection process		30.9%	25
Not very important; other environmental factors trump ingredient transparency		1.2%	1
Materials are not selected based on ingredient disclosure		3.7%	3
		Total Responses	**81**

Are there interior material ingredient(s) that you avoid due to adverse environmental impacts?

Response	Chart	Percentage	Count
No		22.7%	17
Yes (please list:)		77.3%	58
		Total Responses	**75**

Are there interior material ingredient(s) that you avoid due to adverse environmental impacts? (Yes (please list:))

#	Response		
1.	There's several! Old PVCs to name one	27.	anything that we can say off gasses.
2.	silica, bleach,	28.	VOC'S, ADHESIVE OFF GASSING CARPETS, FLAMMABLE RATINGS
3.	Vinyl, Melamine, certain plastics, leather, animal products	29.	Carpet
4.	Formaldehyde	30.	asbestos, formaldehyde
5.	PVC, Urea-formaldehyde, VOCs	31.	VOCs
6.	concrete, manufactured counter top plastics,	32.	Anything high in VOCs, Any rare wood that is not FSC cert, Materials coming from too great a distance
7.	many types of plastics	33.	vinyl
8.	Too many to list	34.	PVC
9.	Materials red list	35.	vinyl chloride
10.	Polyurethane	36.	any toxic materials
11.	Formaldehyde, Phthalates and other glues and plastics	37.	Non-Recyclable materials, VOC paint
12.	Antimicrobials, Ortho-phthalates	38.	Alkyd Paints, PVC,
13.	Halogenated flame retardants	39.	VOCs, formaldehyde
14.	mercury, lead, arsenic, other heavy metals	40.	Asian pacific manufactured products
15.	Vinyl, plastic laminate (if possible)	41.	Off gassing
16.	PVC, UF	42.	this is a matter of prioritizing less impactful materials over those with a greater life-cycle impact, we don't have a specific blacklist
17.	Volatile Organic Compounds, Heavy Metals	43.	Toxic glues and lacquers
18.	items not tagged low VOC	44.	usually Google ingredients to see ratings
19.	There are so many, but here are a few...formaldehyde, lead, cadmium, VOCs...I will stop here.	45.	Vinyl, Formaldehyde, High VOC content
20.	lacquers - oil based products	46.	rare woods
21.	urea formaldehyde	47.	anything with high VOC's

22.	Wood that is not FSC certified	48.	toxic/off-gassing
23.	Varies by project	49.	Materials with high VOC content
24.	Mostly asbestos, VOCs	50.	PVC
25.	PVC, asbestos, non-organic plastics	51.	Ingredients that affect air quality and / or water supply. Eg. alkyd / oil paints when there is a low-VOC alternative.
26.	VOCs	52.	Acrylic sink
		53.	asbestos, etc.

Do you have experience in working with, and specifying materials for, LEED v4 Material & Resources credits:

Response	Chart	Percentage	Count
Yes		21.2%	17
No		78.8%	63
		Total Responses	**80**

Which of the available LEED v4 Materials and Resources credits are most commonly utilized on your current projects (or are referenced if using LEED v4 as a template for sustainable building systems) – select all that apply:

Response	Chart	Percentage	Count
Building life-cycle impact reduction (MRc1)		56.2%	9
Building product disclosure and optimization - environmental product declarations (MRc2)		25.0%	4
Building product disclosure and optimization - sourcing of raw materials (MRc3)		18.8%	3
Building product disclosure and optimization - material ingredients (MRc4)		43.8%	7
		Total Responses	**16**

Do you have experience in working with, and specifying materials using, the Cradle to Cradle (C2C) product certification system:

Response	Chart	Percentage	Count
Yes		30.0%	24
No		70.0%	56
		Total Responses	**80**

Do you experience barriers in specifying products with C2C certification?

Response	Chart	Percentage	Count
Yes (please explain:)		41.7%	10
No		58.3%	14
		Total Responses	**24**

Do you experience barriers in specifying products with C2C certification? (Yes (please explain:))

#	Response
1.	definition and extent of closing the loop
2.	Sometimes more expensive - too expensive for the client budget
3.	How much is the product C2C
4.	There are too many rating systems out there with conflicting requirements
5.	disposal of said materials is limited (i.e ceramic tiles can be C2C certified, however once installed it is very difficult to recycle these materials because of the adhesives)
6.	Not a very common designation yet at least here in Canada
7.	finishes
8.	There are no guarantees that C2C gets the material back into the product manufacturing loop, though with some large volume materials like commercial carpet we feel more confident
9.	More product choice required

Do you have experience in working with, and specifying interior materials with EPDs (environmental product declarations):

Response	Chart	Percentage	Count
Yes		27.8%	22
No		72.2%	57
		Total Responses	**79**

Do you experience barriers in specifying products with EPDs?

Response	Chart	Percentage	Count
Yes (please explain:)		23.8%	5
No		76.2%	16
		Total Responses	**21**

Do you experience barriers in specifying products with EPDs? (Yes (please explain:))

#	Response
1.	Not all Manufacturer's present the facts appropriately, chemicals are not differentiated by

	format i.e. liquid, solid, gas which matters
2.	Some limitations in the quantity of products available information
3.	Manufacturers not supplying information readily
4.	We look for these on occasion when available - comparisons between competing products are nearly impossible due to the lack of consistency in manufacturers' adoption of EPDs

Does the availability of an EPD assist in selecting an environmentally preferred interior material?

Response	Chart	Percentage	Count
Yes		90.0%	18
No		10.0%	2
		Total Responses	**20**

Do you have experience in working, and specifying interior materials, with LCAs (life-cycle assessments):

Response	Chart	Percentage	Count
Yes		37.2%	29
No		62.8%	49
		Total Responses	**78**

Do you experience barriers in specifying products with LCA reports?

Response	Chart	Percentage	Count
Yes (please explain:)		28.6%	8
No		71.4%	20
		Total Responses	**28**

Do you experience barriers in specifying products with LCA reports? (Yes (please explain:))

#	Response
1.	I'm only vaguely familiar, not sure what I need to look for.
2.	Data used to create them is not transparent
3.	Some limitations in product availability
4.	manufacturers disclosure
5.	not enough research for some products
6.	Too few available LCAs, and too little time to be practical.
7.	not sure if end user will recycle or dispose as intended

Does the availability of an LCA report assist in selecting an environmentally preferred interior material?

Response	Chart	Percentage	Count
Yes		82.1%	23
No		17.9%	5
		Total Responses	**28**

What do you feel are the biggest barriers to specifying environmentally preferred interior materials (select all that apply):

Response	Chart	Percentage	Count
Lack of product selection for environmentally preferred interior materials		32.1%	26
Lack of information on benefits		21.0%	17
Unclear of product certification processes		32.1%	26
No common or clear product label(s) or standard(s)		42.0%	34
Not required to meet project/client requirements		56.8%	46
Not enough time to conduct research to make decisions		37.0%	30
Other, please specify:		25.9%	21
		Total Responses	**81**

What do you feel are the biggest barriers to specifying environmentally preferred interior materials (select all that apply): (Other, please specify:)

#	Response		
1.	Cost to client for certification. I do specify preferred materials	12.	Client not interested
2.	Client usually doesn't have the budget to allow for us to spend the time to be mindful of LEED points.	13.	Cost
3.	cost	14.	time is short; pushing back against greenwash is exhausting; sales reps often have no clue what their product certifications and the manufacturers' claims actually mean; clarifications requested from sales reps and manufacturers on environmental claims often go unanswered or are not fully addressed; different certifications will be

			used by various competing products with similar claims; the standards for many tests are not publicly available, used infrequently and collectively cost too much for a small firm to purchase; the basic science needed to effectively evaluate environmental claims is not well understood by many colleagues, sales reps and clients
4.	Not enough budget .... ever.	15.	not sure if end user will follow disposal recommendations by mfg.
5.	Lack of accurate information. Too much green washing	16.	cost
6.	suppliers are uninformed of the products properties/certification process/environmental aspects	17.	cost
7.	Lack of list of product ingredients even if certified.	18.	Similar products have different certifications, making it hard to compare.
8.	client lack of interest	19.	rely on wholesalers & industry shows to see and get knowledge of new products
9.	I need more education (CEUs) in this area to feel more competent	20.	Cost
10.	biggest is cost	21.	not enough financial resources available in the firm to cover this research
11.	no known common database to find all environmentally preferred interior materials- so much legwork involved in finding them		